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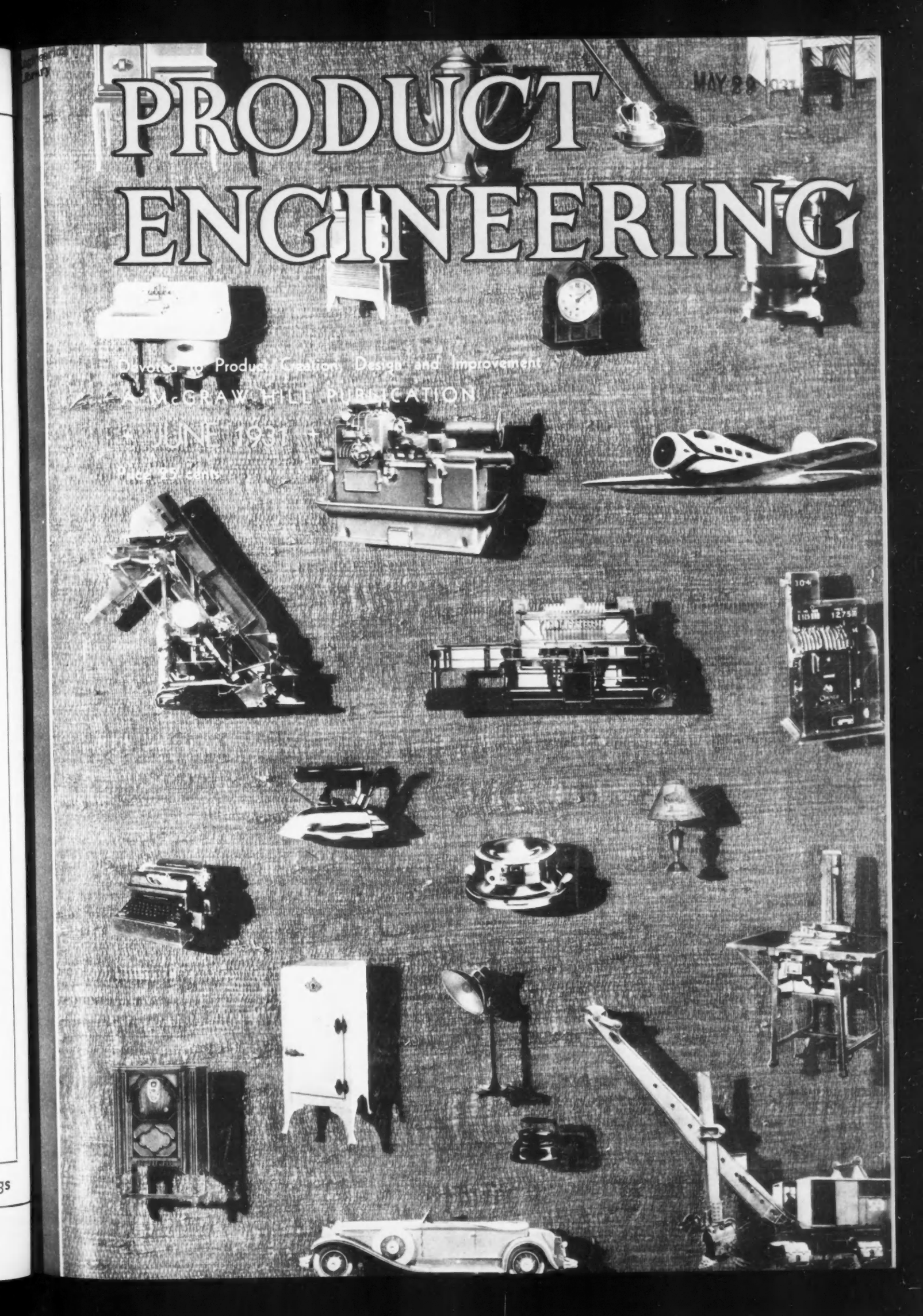
PRODUCT ENGINEERING

Devoted to Product Creation, Design and Improvement

A McGRAW-HILL PUBLICATION

JUNE 1931



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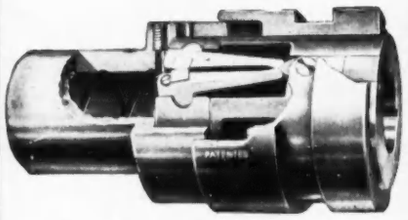
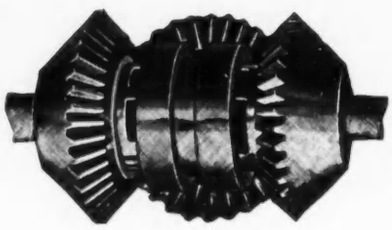
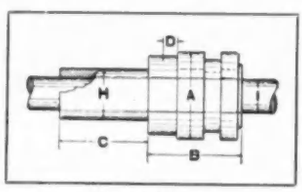


Single Clutch, Sectioned, Showing Working Parts

FOR HIGH SPEEDS



Double Clutch Between Bevel Gearing



Single Clutch

SMALLEST SIZE		LARGEST SIZE	
A—3 7/16	inches	A—11 3/4	inches
B—3 1/4	"	B—8 1/4	"
C—2 to 3	"	C—7 to 10	"
D—5/8	"	D—1 7/8	"
H—1 11/16 to 2 3/8	"	H—5 3/8 to 5 11/16	"
I—1 1/4 or less	"	I—3 1/2 or less	"

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Devoted to the Interests of Engineers and Executives Responsible for Product Creation, Design and Improvement

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Contents for June, 1931

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And, in recognition of the changing attitude toward the teaching of machine design, it is proposed to develop elementary and advanced textbooks on the subject to meet modern requirements.

A Request

The editor and the publishers will be grateful for suggestions of additional topics that should be included, and particularly for recommendations of properly qualified authors. Such comments and suggestions should be sent either to K. H. Condit, editor of Product Engineering, Tenth Avenue at 36th Street, New York City, or to the publishers, McGRAW-HILL BOOK COMPANY, Inc., 370 Seventh Avenue, New York.

PRODUCT ENGINEERING

A McGraw-Hill Publication Volume Two, Number Six

JUNE, 1931

Stress Calculations in Heavy Rotating Structures

By ADOLPH A. MOLINE

Power Engineering Department,
Westinghouse Electric & Manufacturing Company

WITH the present day trend toward larger and more economical generating units, the mechanical engineer is confronted with many new design problems. Factors which make the solution of these problems possible are the increase in the knowledge of the properties of materials and the determination of methods of calculating the stresses and deflections in complicated structures. In machines where speeds double the normal operating speed are common, it is necessary to know accurately the stress conditions which exist. In the following is given a description of how these and other design problems are solved in the vertical waterwheel generator field. It should be recognized, however, that the same problems of arm constructions, designs of built-up rims, and the various stress analyses set forth, apply equally well to other similar construction.

From a mechanical design standpoint, the important elements of a waterwheel generator are the rotor, the supporting bracket, and the Kingsbury thrust bearing. In the conventional type of waterwheel generator, the Kingsbury bearing supports the complete load of the generator rotor, the waterwheel, and the water thrust, on a bracket above the generator rotor. Guide bearings are placed immediately above and below the rotor.

A more recent development of waterwheel generator design, Fig. 1, has a Kingsbury bearing mounted below the generator rotor with one guide bearing on the periphery of the thrust runner. The guide bearing is immersed in the same bath of oil as the Kingsbury bearing. This construction requires no piping for circulating the oil as is the case in the conventional type wherein separate oil housings for the guide and thrust bearing are necessary.

By drooping the arms of the rotor umbrella fashion, the distance between the bottom of the supporting bracket and the top of the frame is kept at a minimum, which reduces the headroom necessary to dismantle the unit and thus saves considerable in building cost. This type of construction is best suited for slow-speed large-diameter machines. The generator rotor, subject to runaway speeds of 100 per cent greater than normal speed, must be designed to withstand four times the normal centrifugal stresses and still have a reasonable factor of safety.

In the rotor, the dovetails that fasten the pole pieces and coils to the spider are of primary importance in stress calculations. The actual stress distribution in the dovetail is quite complex and studies are made by photoelastic and Luder's lines methods. The main stresses are tensile

stress across the neck, as shown at *A* in Fig. 2, and the compression stress at the base, as at *B*. The two principal stresses along the centerline of the pole and dovetail as determined by photo-elastic analysis are shown at *B*, Fig. 3, graphically.

Two types of dovetails are commonly used in the rotor construction; namely, triangular and square. In the triangular dovetail, *A*, Fig. 3, the pole centrifugal force *P*, will be balanced by reactions of magnitude:

$$\frac{P}{2 \sin \alpha}$$

normal to the sides. Adding vectorially the two forces on the section between the dovetails, the resultant force transmitted to the spider is:

$$R = \frac{\text{Sin } (\alpha + \beta)\ P}{\sin \alpha}$$

Here *R* will be greater than *P*.

In the case of the square dovetail, Fig. 3, the force is:

$$R' = (\cos \beta)\ P$$

This makes *R'* less than *P*.

A disadvantage found in the use of the square dovetail, is that a greater depth in the rim is required.

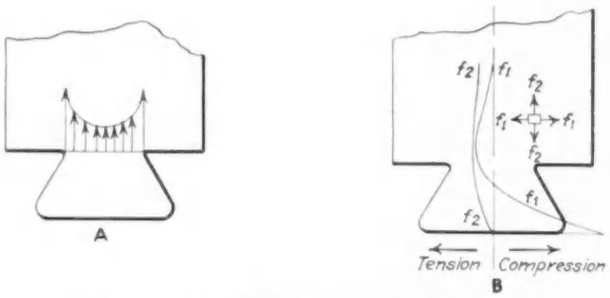


Fig. 2—Stress distribution in dovetails. At *A* the main tentile stresses across the neck; at *B* stresses along centerline of pole and dovetail as determined by photo elastic analysis

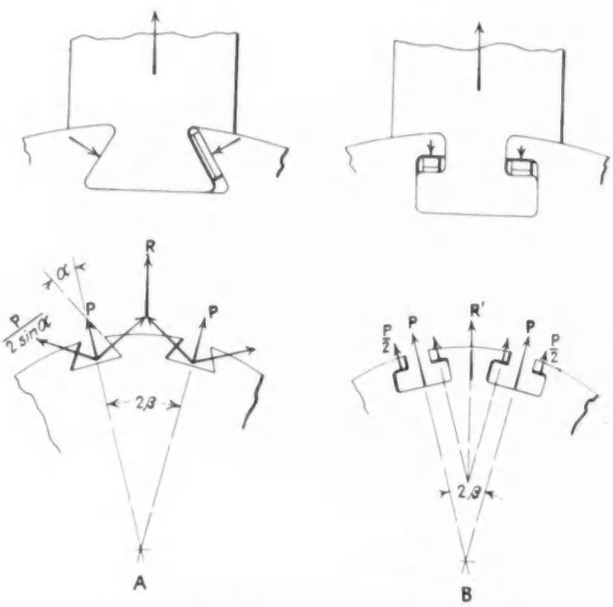


Fig. 3—Triangular type and square type dovetails and diagram of forces and reactions to balance the pole centrifugal force

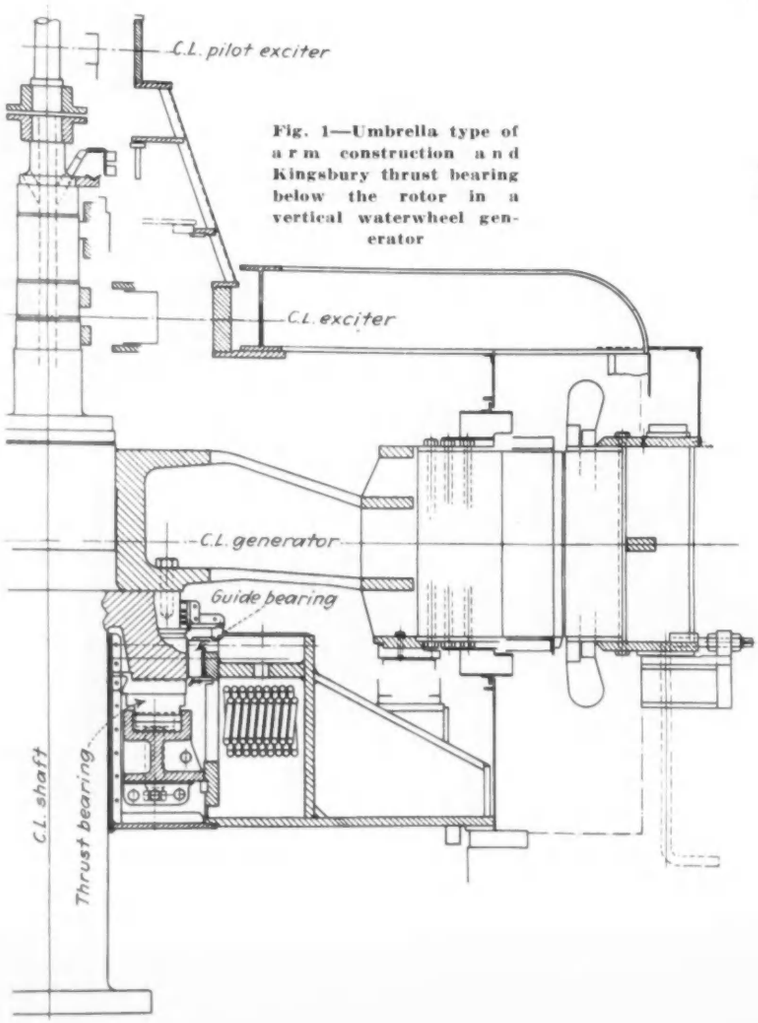


Fig. 1—Umbrella type of arm construction and Kingsbury thrust bearing below the rotor in a vertical waterwheel generator

For small diameter high speed units, the spiders are usually constructed of disks, either in the form of thin laminations as in Fig. 4, or thick plates. To calculate the bore stress in this type of spider, it is assumed that the total centrifugal force of the pole pieces produces a uniform load on the circumference. The theory of a uniformly loaded rotating disk, as given by Lammè, is used to determine the stress distribution. In Fig. 5 is shown a diagram of the stress distribution.

For large spiders, where solid rolled material of the required diameter cannot be obtained, a different construction involving a cast spider or a combination of cast spider and built-up rim, is used. The stress distribution in the arms and in

the rim of a cast spider are indicated in Fig. 6. The centrifugal forces of the poles and the rim produce tensile stresses in the arms of the spider and bending stresses in the rim for the uniform loading on the rim is supported in the manner of concentrated reactions at the arms. The direct tensile stress in the outer fibers of the rim at the mid-section is sometimes increased 100 per cent by the bending moments. Additional factors creating stress in the arms are torque loads and the rim weight. The bending stresses in the rim may be relieved by shrinking the rim on the arms.

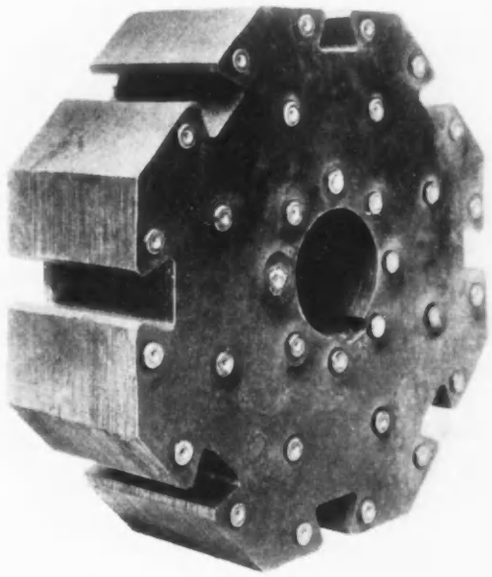


Fig. 4—Spider built up of laminations

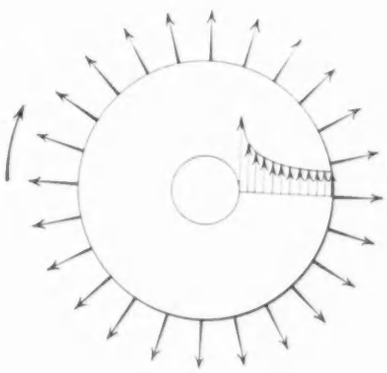


Fig. 5—Stresses in a rotating disk uniformly loaded externally

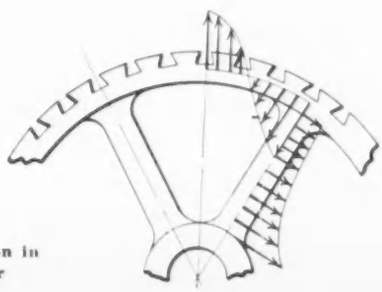


Fig. 6—Stress distribution in a completely cast spider

although this type of construction is used mainly on large machines to eliminate casting and shipping difficulties.

The built-up rim is usually made of segmental laminations, staggered in such a manner that the ends of the segments come at alternate positions. Long bolts through the laminations make the rim one composite structure. The original practice required that the bolt pressure be great enough to hold the punchings in place by friction; the rim was considered a friction-bound ring. The limitations of this design are the possible pressures attainable on through bolts and the coefficient of friction of the punchings. Since the coefficient of friction is about 0.15 for punching material, very high initial pressures are necessary for safe operation.

The method now used is to let the rim act as a "linked" structure; that is, the segments, as links, are pinned together by through bolts. With this construction there is no necessity for friction binding, and all the centrifugal loads are carried by the bolts in shear and by the laminations in direct compression, the pressure of the bolts being against the side of the holes in the lamination.

In order to analyze the mechanics of such a structure, an investigation of a laminated rim, stacked so that every fifth layer is repeated, is made. A section of four layers of punchings will be representative. From a friction standpoint, any section across a split would involve the strength of three punchings out of four, as shown at *A* in Fig. 7. But if the effects of friction are neglected in the "linked structure" and it is assumed that each bolt carries its share of the load, the stress distribution for one segment will be in the form of a rectangular polygon as indicated at *B* in Fig. 8. The stress *f* is the maximum working stress. To obtain the force in any section for the set of four laminations, four such force distribution curves are superimposed with their proper phase displacements, as at *C*, Fig. 7. It follows that, for a set of four punchings, the force at any section is only twice the maximum force that any one punching will carry, and that only one-half of a given section may be considered effective. Thus, in order to limit the maximum stress to a predetermined value, the computed average stress is limited to one-half the maximum. The number and size of the through bolts are determined from the relation of the compressive stress in the punching at the bolt to the yield point of the material. The shearing stress in the bolt in most cases is low. By using long punchings and properly spacing the bolts, it is possible to increase

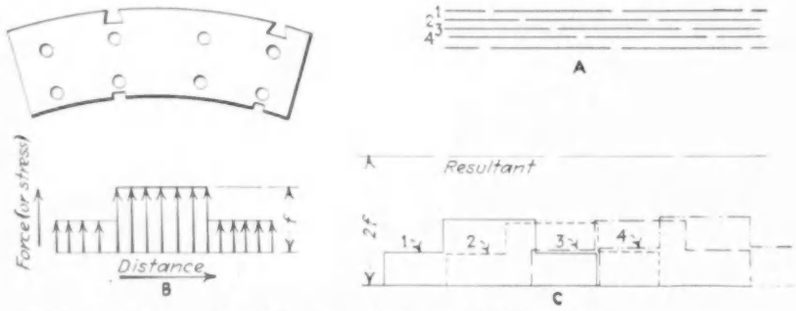


Fig. 7—Method of stacking punchings in a built-up rim is shown at *A*. At *B* is shown the stress distribution along the rim of a punching and at *C* is shown the superimposed stress diagram for the set of 4 laminations

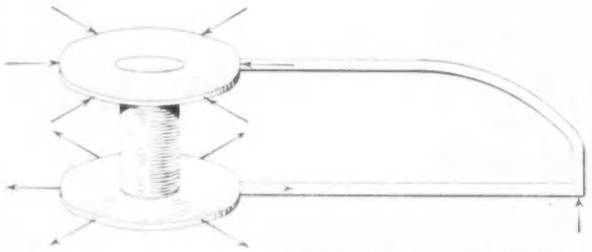


Fig. 8—Upper bracket idealized for stress and deflection calculations

the effective section to as high as five-sixths of the total section.

The upper bracket as shown in Fig. 1, supports the entire rotating mass through the thrust bearing, including the generator rotor, the water turbine, and the water thrust. Adequate strength must be provided in the design to limit vertical displacement due to deflection, and to obtain sufficient rigidity to eliminate vibration. In Fig. 8 is indicated schematically how the structure is idealized to permit calculations of deflections and stresses.

The total deflection of the upper bracket consists of three specific types of deformation:

1. Radial deformation in the upper and lower rings,
2. Bending in the arms,
3. Shear deformation in the arms.

Stress considerations involve the bending stresses in the arms, and the compressive and tensile stresses in the upper and lower rings respectively.

To visualize the operation of a Kingsbury thrust bearing, consider a flat metal table, with a ledge around it, containing oil. If a rectangular metal plate supporting a weight is placed in the oil, the plate will sink and squeeze out practically all the oil between it and the table. If, however, the plate is pulled along the table by a horizontal force, it will tilt up at the advancing end, and move along in that position, floating on a thin, wedge-shaped film whose mean thickness depends on the load, speed, and the viscosity of the oil.

Since the weight is floated on the oil film, the sum of the upward pressures within the liquid must equal the load supported. The mean pressure is the weight divided by the surface area of the shoe. The pressure used in the commercial Kingsbury bearing varies from 300 to 500 lb. per sq.in., the higher pressure being used at the higher velocities. The actual pressure varies from zero at the edges of the shoe to a maximum at a point about over the support.

The force necessary to move the loaded plate along as it floats on the oil film depends upon the velocity, viscosity of the oil, and film thickness.

The application of the above principles to the Kingsbury thrust bearing is illustrated in Fig. 9. The loaded plate in this case is constrained to move horizontally. It rests on several shoes that tilt on pivots, and allow the oil film to assume the wedge form.

The Kingsbury bearing is immersed in a bath of oil in a pot supported on the upper bracket. The loaded plate or runner is fastened to the end of the generator shaft. When the bearing losses become excessive so that additional cooling is required, coils of pipe through which water is circulated are placed in the oil pot around the bearing.

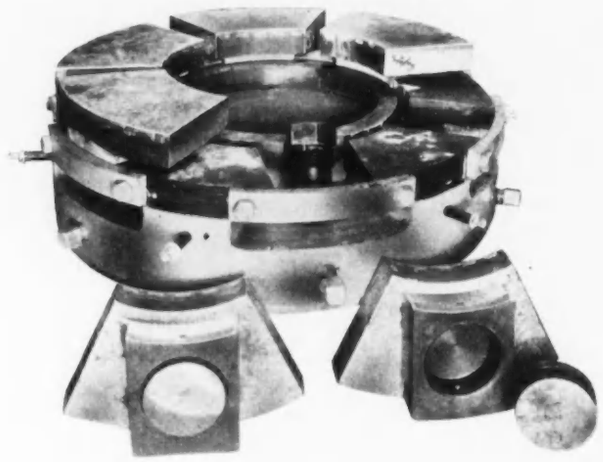


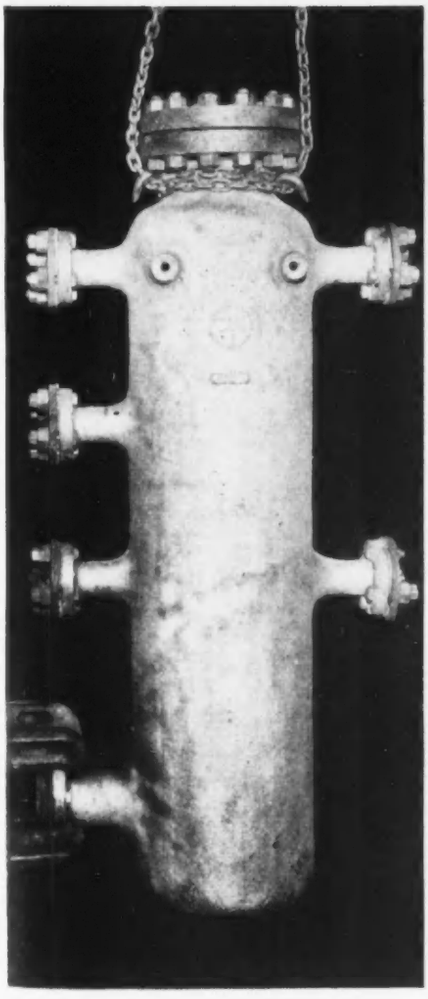
Fig. 9—Kingsbury thrust bearing showing the adjustable shoe supports for equalizing the shoes under pressure. Sometimes the shoes are supported on a system of links to make adjustment automatic

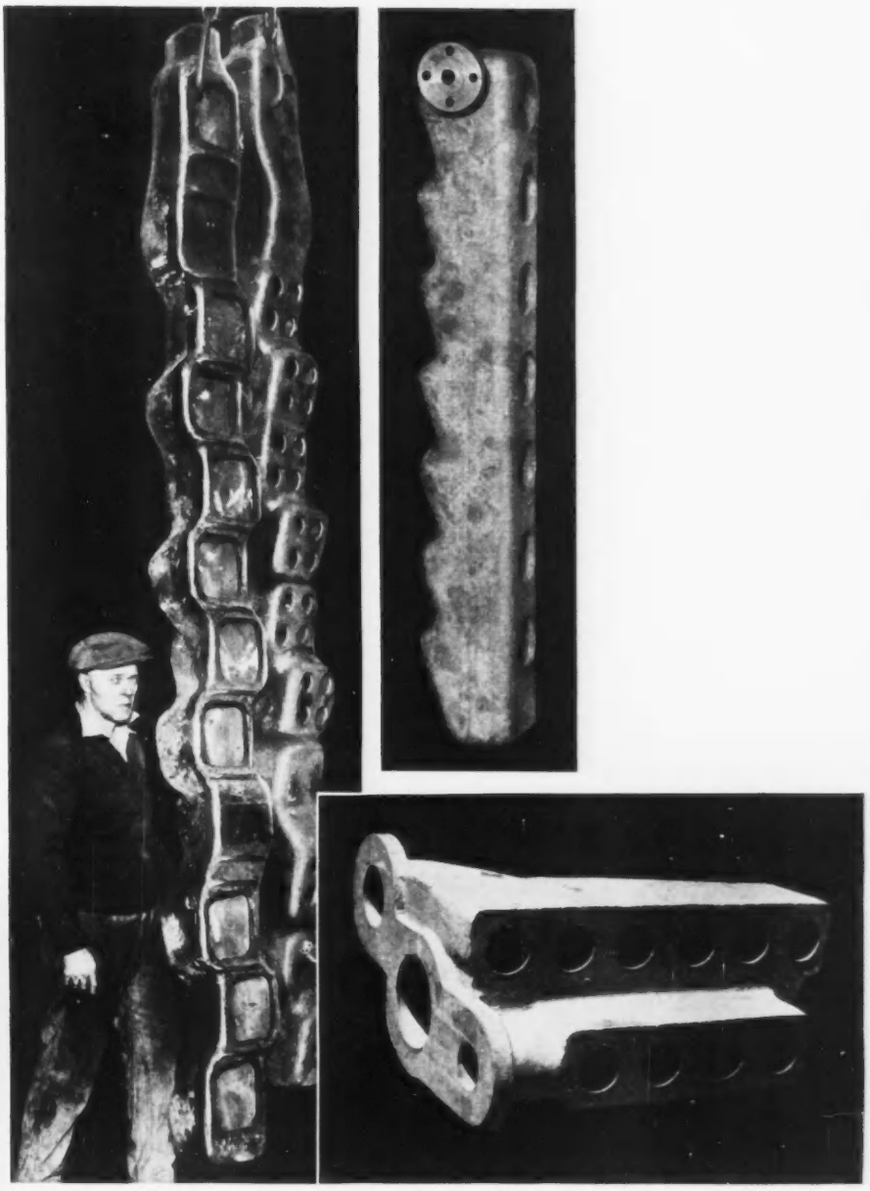
In the type of bearing shown, the shoe supports are adjustable to allow the shoes to be equalized under the load. The shoes are sometimes supported on a system of links to make the adjustment automatic.

High Pressure with Steel Castings

By WM. H. JACOBI

General Manager, Keokuk Steel Casting Company





RECENT demands for materials for products handling superheated steam, and for pressure vessels in chemical processing equipment, have been met successfully by cast steel. Headers, drums, cylinders and other parts that would be difficult or expensive to make by other methods are now cast in steel. Though not generally known, during the past few years progress in the process for casting steel has developed to the point where a homogeneous material is obtained, and blow-holes are rarely encountered in castings made under modern foundry control methods.

All of the parts shown here are of carbon steel containing from 0.275 to 0.300 per cent carbon. Tensile strengths average 75,000 lb. per sq.in., elastic limit, 41,000 lb. per sq.in. elongation, 27 per cent, and reduction in area, 39 per cent. Where higher physicals are required, alloy cast steels with tensile strengths above 200,000 lb. are obtainable.

These values for carbon steel are sufficiently high to achieve well-balanced design for such parts as boiler headers operating at steam pressures up to 500 lb. per sq.in. or over, now encountered in industrial equipment. The boiler header shown is 11 ft. 2 in. in length, with walls of $\frac{5}{8}$ in.

At the left is a high-pressure desuperheater for oil-refinery service, which has been tested to a hydrostatic pressure of 2,000 lb. per sq.in. Obviously, it would be practically impossible to forge such a shape, but as a steel casting, it is made without inherent difficulties. Above, at the right is a Worthington pump cylinder for high-pressure boiler feed service,

✦ ✦ ✦

Control of the Budget in Design

An interview with
W. C. STEVENS
Director of Development, Cutler-Hammer, Inc.

TO DEVELOPMENT COMMITTEE: Request for appropriation for development of:

Name of Device _____ Bulletin No. _____

Annual Quant. _____ List Price _____ x equals _____ Net Price

TOTAL DEVELOPMENT COST L.M.S.		MARKET LIMITS ON COST	
Spent to date		Net Price	
Further experimental design		Divided by Commercial Factor	
Dev. Eng.		Equals Factory Cost	
Drafting		Divided by 1. – % group dev.	
Experimental		Equals M.L.B. Dev. Cost	
Production Drawings		Less Dev. Writeoff	
Patent		Equals Max. M.L.B. Cost	
Tool Check			
Eng. Data			
Routing			
Instruction Sheet		ESTIMATED ACTUAL COST	
		Material	
Label		Labor	
Final Hand Made Sample		Burden	
Underwriters Approval		Dev. Writeoff	
Production Samples			
Obsolescence of superseded Device		TOTAL	
		% Group Dev.	
		TOTAL FACTORY COST	
Total General Development		Times Equals	
		TOTAL COST	
Tools			
Patterns			
TOTAL DEVELOPMENT COST		TOTAL ANNUAL PROFIT	

Note:- The two sections at the right, above, are entirely independent. The upper section starts with Net Selling Price and figures back to M.L.B. cost which must be met to yield normal profit. Use Total Dev. cost in figuring writeoff for this item. The lower section starts with Estimated Cost of actual device contemplated and gives total cost including Selling, Shipping and Administration, but no Profit. If working from a regular estimate in which tools and patterns have been included, use General Dev. total only in figuring writeoff for this item. Otherwise use Total Dev. Cost and include something for tool and pattern maintenance. Net Price less Total Cost equals Profit each.

First design conference minutes attached – attended by

Sales _____ Engineering _____ Mfg. _____

Must device be ready at any particular time to meet any special or seasonal demand?
What previous device will it supersede?
On which annual profit has been?
Reason for development of new device:

Signed _____ Date _____

DEVELOPMENT and factory costs are estimated on this form, then checked against the market limits on the net price to determine profitability of product

EVERY PRODUCT must carry its proportionate share of the overhead and make a profit; otherwise it has no place in the varied line of electrical control apparatus made by the Cutler-Hammer company. To carry out this plan it has been necessary not only to estimate sales totals and cost of manufacture, but also to budget development costs, almost as soon as the idea is conceived. In this type of commercial research it is possible from past experience to gage expenditures within reasonable amounts. As the work proceeds, the larger variables become a matter of record, particularly the cost of the preliminary engineering conception, and the remaining steps are subject to close control. By the time the idea has crystallized into a model, the probable development costs are known and a final decision can be made with assurance.

Development work is carried on by a development department whose expenditures and broad scheme of activities are controlled by a development committee. This controlling body, which meets fortnightly, is made up of representatives of the sales, manufacturing, engineering, development, and patent departments, with the director of development acting as chairman. Its object is to develop new products to meet new demands at predetermined prices, and its control follows through from the inception of the idea until the model is obsolete and superseded by a newer development. Up until 1924, a development division was a part of the engineering department, and as such was a secondary function. Today, while fundamentally an engineering organization, it is distinct from the engineering department, which is largely concerned with special customer applications of the product.

Standardization is an important function of the development department. As soon as a wider market is found for an engineering device, for example, it may be turned back to the development department for redesign and standardization so as to be produced in quantity at the lowest cost.

When this division became an entity, it had as a personnel two engineers and two model makers. Now there are almost fifty persons in the department. Reporting to the director of development are ten senior project engineers, each technically responsible for his own jobs, and assisted by three routine men and a chief clerk. In the experimental department there are twelve to fifteen technical graduates on test work and about the same number of tool and model makers. The chemical laboratory also is under the control

of the development department. There are no draftsmen in the department, but in the main drafting room a certain number of men are allocated for development work, although they remain under the discipline of the engineering department. In fact, any department in the plant may do work on an experimental or development order, with charges made against that order. The development department issues all tool and tool maintenance orders, so that this expense may be charged directly against development of the specific product throughout its life.

As is often the case in an organization of this kind, the director is an administrator rather than a highly technical engineer. The fact that he was for many years sales manager of the company, having previously served in various capacities as engineer, salesman, and district sales manager, suggests that he is thoroughly familiar with the products and the customer aspects of development. For engineering talent, reliance is placed upon the technical specialists, or project engineers, over whom the director exercises control.

Development work may be initiated by any department of the company, including sales, engineering, production, or the development department itself. The object may be to reduce the cost of the product to meet a price situation, to develop a new product to meet competition, or to produce an apparatus to accomplish a specific job according to sales or customer demand.

Once the project is conceived, a request is made to the development committee for an appropriation to cover the entire cost of development. On a mimeographed form a breakdown estimate of development costs is made, and the actual cost of production is estimated in the usual way by adding material, labor, and burden to the development write-off based on the sale of an estimated quantity annually. In the manufacture of electrical apparatus, where obsolescence plays such a major part, the average time of write-off of development costs is figured as two years. To this production cost is added a group development charge, giving the total estimated factory cost. The charge for selling, shipping, and administration expense is accounted for by multiplying by an over-all factor. The figures are checked from the other direction by starting with the

CUTLER-HAMMER, Inc.

APPLIED APPARATUS EXPENDITURES — MONTH OF _____ 193__

DESCRIPTION	CURRENT MONTH: BASE	CURRENT MONTH: EXTRA	CURRENT MONTH: ACTUAL	TO DATE THIS YEAR: AUTHORIZED	TO DATE THIS YEAR: ACTUAL
TIME APPLIED TO DEVELOPMENT ORDERS					
C-26 TOOL — MONTHLY — NEW					
— MAINT.					
— HOURLY — NEW					
— MAINT.					
C-27 PATTERN — WEEKLY					
— HOURLY — NEW					
— MAINT.					
C-60 MATERIAL LIST					
C-63 ENGINEERING					
C-64 DRAFTING					
C-70 PATENT					
C-78 PRINTING					
C-81 DEVELOPMENT — MONTHLY					
— HOURLY					
C-81 DEVELOPMENT — WEEKLY					
OTHER MILWAUKEE DEPTS. — HOURLY					
Y-63 DRAFT AND ENG. N. Y. WORKS — WEEKLY					
Y-26 TOOL — HOURLY — NEW					
— MAINT.					
Y-26 TOOL — WEEKLY					
OTHER N. Y. WORKS DEPTS. — HOURLY					
TOTAL APPLIED TIME					
SUB-TOTAL					
OVERHEAD ON ABOVE					
PATENTS—PURCHASE OF PATENT RIGHTS					
DAMAGES PAID					
DAMAGES RECEIVED					
ROYALTIES PAID					
ROYALTIES RECEIVED					
OUTSIDE ATTORNEYS AND EXPERTS					
DISBURSEMENTS FROM C-H PATENT DEPT.					
SUB-TOTAL					
MATERIAL FROM INVENTORY—MILWAUKEE—RAW MAT'L					
—FINISHED STOCK					
—NEW YORK WORKS					
MATERIAL PURCHASED—MILWAUKEE					
—NEW YORK WORKS					
—TOOLS, JIGS AND DIES FROM VENDORS					
POWER APPLIED TO ORDERS					
TRAVEL APPLIED TO ORDERS					
OUTSIDE TECHNICAL SERVICE					
UNDERWRITERS FEES					
MISCELLANEOUS					
DISPOSAL ORDERS CLOSED THRU DEV. 10 SERIES					
COMPLAINT ORDERS CLOSED THRU DEV. 30 SERIES					
SUB-TOTAL					
TOTAL APPLIED TO APPARATUS EXPENDITURES					
AMOUNT LIQUIDATED INTO COSTS DURING MONTH					

FORM 20580

MONTH BY MONTH total budgeted expenses of the department are checked by detailed breakdown against actual expenditures

NO DETAIL is left to chance in scheduling the development of a new product up to its release for sale

Date_____ Dev. No._____
Device_____

Variations_____

Annual Quantity_____
Will be stocked as_____

Sub-Assemblies_____

Supersedes_____

Purch. Mat. will be ordered_____

Charge to Part No._____

	From	Fin.
Prod. Dwgs.		
Obs. Breakdown		
Pre-Release Dwgs.		
Hand-Made Samp.		
Purchased Mat.		
Patterns		
Tools		
Routing		
Prod. Samples		
Packing		
Spec. M.P. or Decal		
Packing Labels		
Inst. Labels		
Electrical Data		
Eng. Data		
Release for Prod.		
Book		
Samples to Und.		
Release for Sale		

Notes: Sheet

assumed net price and working down to the maximum material-labor-burden cost that must be met in order to yield a normal profit.

If this preliminary estimate is approved by the committee, the design is prepared, usually in the form of rough sketches, and a model constructed, approved, and tested. From this model, a careful check is made of the labor and material costs, as well as a rough estimate of the tool cost. Armed with these figures, supplemented by reports from the test engineer and model maker, giving performance data, the project engineer undertakes to get the approval of the device from the manufacturing, sales, engineering, and patent departments. Once this is secured, a redraft is made of the request for an appropriation, using the more accurate figures now available.

After approval by the development committee there is held a planning conference at which all department heads discuss how the device will be manufactured, how stocked, what part assemblies will be stocked, how the device will be boxed, and how sold. A schedule is then prepared showing the probable date of completion of all phases of the work. This information is assembled on a mimeographed form with provision for recording the promised dates and the finished dates.

On order from the development department the production drawings are prepared and the tools made. From them a sample is built by the experimental department and given a careful recheck by the development department. When all departments are satisfied, the development department gives its release for production. In the meantime the project engineer compiles a technical report for the advertising and engineering departments, from which labels, instruction sheets, repair parts sheet, bulletins, and advertising copy are prepared. The boxing requirements are also determined, the cartons obtained and drop-tested.

Expenditures on every development order are checked monthly by the accounting department. All expenses incurred in connection with the development of the product is absorbed in its sales price. Each month an analysis is made of the applied apparatus expenditures of the department on a form showing by divisions of the work whether or not the budgeted expenditures of the department are being maintained, month by month, and also the cumulative totals. Separate check on 42 different groups of products is also made by comparing development charges and credits based on the net sales for the month. By careful checks the likelihood of putting into production a product that will not be profitable is lessened.

Condemnation of New Ideas

By Paul B. Swinton

PERHAPS many companies exhibit the same attitude toward new ideas and product developments as illustrated in the story told by Philips of Valley Steel concerning the Reproduction Manufacturing Company.

"They turned down Sparks cold when he first came around with his patents and asked them to develop the machine on a co-operative basis. Told him that the machine couldn't possibly work, and if it did it would have no commercial value.

"Sparks had the vision and even the cash," said Philips. "His proposition to the Reproduction Manufacturing Company was that he would put up $30,000 for which the company would turn out a machine that would be mechanically correct. In return he would agree to license them as sole manufacturers. The estimated cost of the machine, exclusive of engineering, was $18,000. The Reproduction crowd stood pat for cost plus.

"Being dissatisfied, Sparks came to us with the same proposition, and we came to an agreement. The first machine cost us $23,000 to build plus $9,000 engineering. We were out $2,000. But we will manufacture ten of the machines this year, and our profit on each is considerably more that what we had lost on the first one."

"You took a lucky chance," commented Meyers of the Bronson Company.

"No, we didn't," retorted Philips. "The other crowd simply condemned Sparks' idea without investigating. They tried to tie him up so that they would be sure to get a good profit on the first machine, feeling certain there wouldn't be any second. On the other hand, we had our engineers analyze the patent drawings and make preliminary calculations and layouts. We then interviewed a number of contractors as to the commercial possibilities of the machine. Then we closed with Sparks.

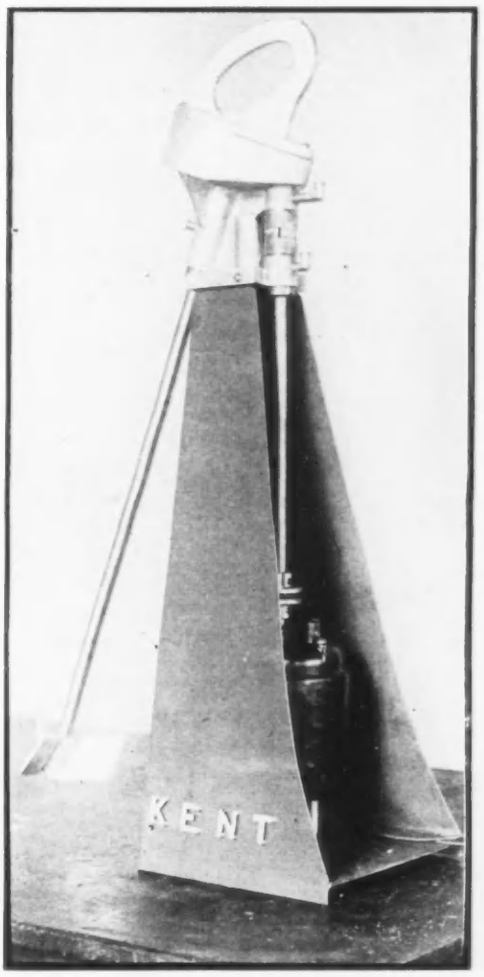
"Incidentally, the Reproduction Manufacturing Company tried to put out a similar machine to do the same work, after the success of the machine that we had developed for Sparks had been established. They were licked in the patent suit, had to pay a handsome royalty on the machine they sold, and lost what they spent for development."

"They're not paying dividends any more," said Meyers. "I understand they're down flat."

"Yes," concluded Philips. "Successful companies do their own product development; and they don't condemn new ideas without an investigation of all the facts.

Developments in Chemical Process Equipment

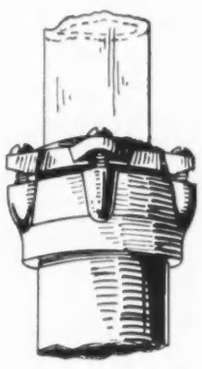
Interviews with engineers at the biennial Chemical Exposition reveal great advances in design



PORTABLE mixer for small liquid batches

DESIGN opportunities, arising from the development of the great variety of new materials and parts, have been utilized by designers in every division of the chemical and process industries. Many of these uses were strikingly indicated in the Chemical Show. Two years have elapsed since the last Exposition of the Chemical Industries instead of the usual year, and this, coupled with present economic conditions, has resulted in radical redesign of many existing units and the development of entirely new ones.

Of particular note is the utilization of recent developments in the application of corrosion-resistant materials for plant and laboratory equipment. Acid- and alkali-proof units of "stainless" steel, high-silicon iron, nickel and its alloys, hard rubber, chemical stoneware, enamelware, chemical lead, phenol-condensation products, and other resistant substances were shown. Many designers use several of these materials in combination. One self-oiling, double-acting, reciprocating acid pump is built of high-silicon iron, with rubber used in several places for abrasion resistance. A high-silicon iron exhaust fan has rubber-faced blades and all moving parts mounted on rubber. Rotors and shafts of one colloid mill are of stainless steel, while the body and pump are of cast iron and the piping and valves of brass. The same mill is supplied with the pump and all parts that come in contact with the chemicals processed made of nickel, Monel metal, or other resistant metals to suit the immediate condition.



GRINNELL 2-in. sight-flow union incorporating Pyrex glass tubing and designed for 150 lb. cold-water pressure with a safety factor of five. Similar units carry hot liquids

Chrome-nickel steels and irons are being provided in an increasing variety of forms. One exhibitor showed long lengths of seamless 18-8 chrome-nickel steel tubing 8⅝-in. o.d. by ½-in. wall, said to be the largest seamless tubing of this material so far made.

Glass-lined equipment included a tank fitted with a two-speed epicyclic agitator which utilizes a simple gear shift to change speeds. The rotating agitator shaft is set off center and moves continuously in a circle about the tank center. Another unit contains a vertical off-center shaft with push-pull propellers. Other ingenious mechanical movements were used in two drying conveyors, one of which maintains trays level while changing direction, and the other which dumps material from tray to tray in order to shake it. The first utilizes a double track, one set of wheels being of wider gage than the other. In changing direc-

tion, one track is extended beyond the other and the tray is thus held level.

Designers of products utilizing rubber showed a number of interesting innovations. "Linatex," a type of rubber recently introduced in the United States, is said to be remarkable for its superior resistance to abrasion. It is made without the use of heat in either coagulation or vulcanization, yielding a material for linings which retain their amorphous condition indefinitely and are affected slightly or not at all by moisture, sunlight, and age. Another self-vulcanizing rubber compound, known as "Colvulc," for resistance to abrasion, used as a covering for conveyor belts or a liner for chutes, has been modified in formula to be used for the lining of many sorts of apparatus for protection against acid corrosion. The material is plastic and is applied as a thin coating, after which it undergoes a cold cure within 24 hr. It is said to be immune to attack by hot concentrated HCl at 200 deg. F. A new hard-rubber valve, made in sizes to 4 in., was shown.

One new use for fused silica is in a spherical ground joint for Vitreosil pipes. This eliminates strains inherent in joints even where there is some misalignment, and yet preserves a seal. A new refractory, "Mono-Bond," is a high-temperature bonding material which is mixed with an equal weight of pulverized firebrick or other refractory to make plastic one-piece linings. The material shrinks only slightly, does not blister or crack, and is easy to apply.

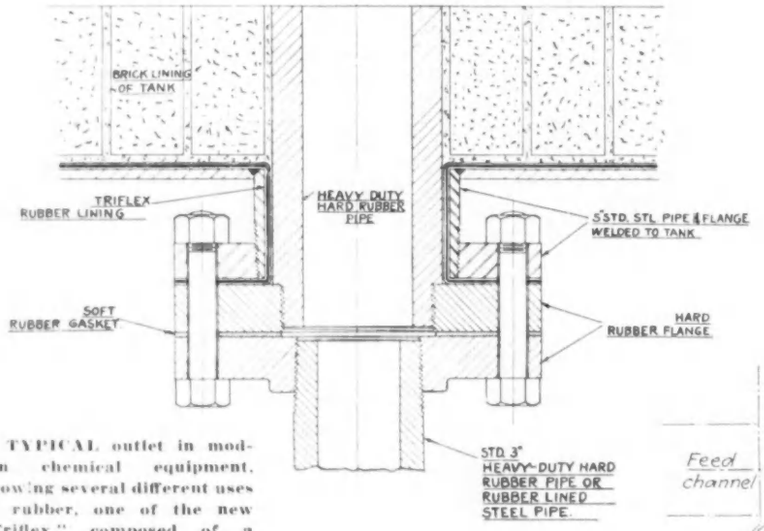
There has been considerable interest in the development of acid-, corrosion-, and temperature-resistant paints. One type shown, "Locomax," is a locomotive front-end paint capable of withstanding about 330 deg. F. "Lumino" is a bituminous-base aluminum paint for temperatures up to 500 deg. F. It is corrosion- and water-resistant and suitable for use on steel, concrete and wood, requiring no priming coat. "Koprime" is a new priming paint especially adapted for use as a first coat under bituminous finishing paint. This primer is bituminous in character, bonds well with the top coating, and results in a firmly adherent protective surface for rust-resisting coatings even under marine service.

The growing use of tantalum plating as a means of resisting the destructive effect of acids, alkalis, and salts was also demonstrated. One type of spinneret for rayon was of tantalum. Platinum linings for valves and chemical apparatus were also shown.

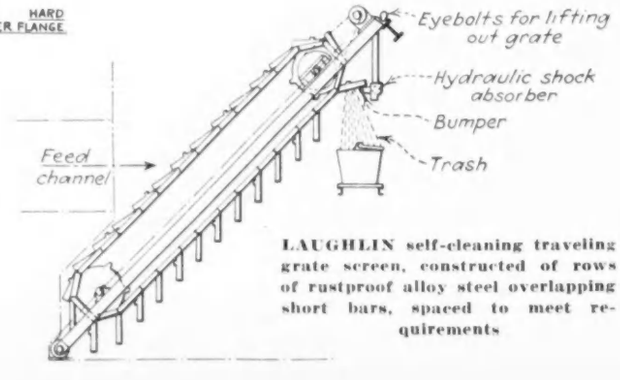
New developments in the use of Monel metal and other nickel alloys occur almost daily. Seamless Monel tubing and pipe ¼ to 4 in. in diameter and in 18-ft. lengths, were shown. Nickel-clad steel plate, particularly applicable for large containers used for transporting caustic soda and for other purposes where nickel alone would be too expensive, can now be obtained with a nickel coating up to ⅜ in. thick. An engine with oval cylinders cast in Niresist was shown.

Solid glass units of various types, using Pyrex glass, are being designed by engineers. It is now possible to carry out a complete plant-scale distillation in glass, distillation apparatus, piping and joints all being available in this material. One company showed a Pyrex ejector available in sizes to 2½-in. suction and discharge for 100-lb. steam pressure.

Among plastics, possibly the newest development was two makes of cast phenol resinoid, which is machinable and has properties much like those of the molded resinoids

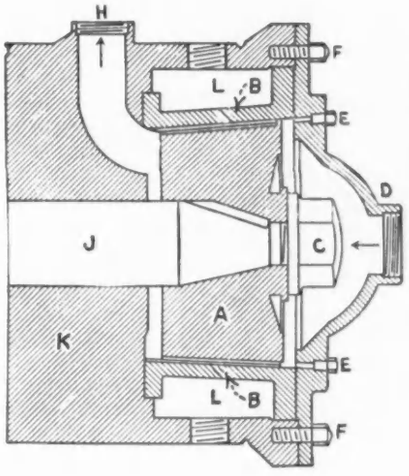

BRICK LINING OF TANK
TRIFLEX RUBBER LINING
HEAVY DUTY HARD RUBBER PIPE
5" STD. STL. PIPE & FLANGE WELDED TO TANK
SOFT RUBBER GASKET
HARD RUBBER FLANGE
STD. 3" HEAVY-DUTY HARD RUBBER PIPE OR RUBBER LINED STEEL PIPE.

A TYPICAL outlet in modern chemical equipment, showing several different uses of rubber, one of the new "Triflex," composed of a layer of semi-hard rubber sandwiched between two layers of soft rubber to gain flexibility and longer life. Brick linings set in acid-proof cement are used



LAUGHLIN self-cleaning traveling grate screen, constructed of rows of rustproof alloy steel overlapping short bars, spaced to meet requirements

without the necessity of forming by heat and pressure. Engineers have succeeded in producing a line of pipe fittings in Dilecto, a fabric-reinforced molded phenol-base resinoid. The same material is used in a 1-in. centrifugal pump which has no metal, except the impeller shaft, in contact with the liquid handled. A new odorless resinoid, Dilecto K-4, has been developed for resistance to alkalis. Another material, known as "Codite," is a modified thermoplastic insulating fiber of excellent machining properties, great toughness, and high dielectric value.



REPLACEMENT of worn members quickly and easily is embodied in this Charlotte colloid mill. Rotor A is held in place on shaft J by means of a key and locknut C which can be removed quickly. The stator B can be pushed out by setscrews in the back of the housing K. D is the cover, F the cover nuts, E drain cocks, G inlet, H outlet, and L water jacket

It was evident at the Show that product designers today must think of ceramics as well as of metals. A new chemical whiteware called "Ceramit" is claimed to be equal or superior to porcelain and usable for much larger apparatus. A roll for textile dyeing, bleaching, and finishing was made of a new ceramic material having a soft body covered by a permanent heavy glaze capable of withstanding a wide range of temperatures and sudden thermal shock. One line of ball mills of stoneware has working parts reinforced with steel. One stoneware centrifugal pump has the impeller shaft protected within the pump by a Sillimanite sleeve and supported outside on a double row of Timken bearings.

Mechanical refinements have been introduced into a number of familiar machines. One colloid mill uses a single rotor, a circulating pump being supplied as part of the machine and the unit being equipped with a bypass to regulate the flow through the mill. One improved double-rotor type uses multiple V-belt drive instead of the direct-coupled drive formerly used. A feature is the "flinger" which is used instead of packing where the shaft enters the rotor housing. There is no contact at this point, although the construction is claimed to be entirely leakproof. One designer avoided undesirable temperature rise in material during processing by using combined pressure and clutching action at comparatively slow rotor speeds instead of the high-speed interfacial shearing action ordinarily used in these units.

One variable-speed spray drying unit is fitted at the top of a tower with a conical surface surrounding the unit through which air up to 1,000 deg. F. is admitted to the material being dried. The spray disk or wheel is of aluminum or other material as required and resembles an automobile wheel with its inner brake band. Into this center cup the material to be sprayed is admitted. It is thrown out radially through a series of slots leading to the periphery of the wheel. Here, however, the designer has introduced a novel idea in taking the disk surface leading to the periphery and splitting it into a number of vanes, some of which carry the material to be thrown to the upper surface of the disk and the remainder carrying it to the lower surface, thus doubling wheel capacity. Wheel speed can be varied from 3,000 r.p.m. to 18,000. Bearings are water-cooled and any material that can enter through a 1½-in. pipe can be sprayed.

A type of double-drum dryer has an improved feeder which incorporates a rotary lock placed in the bottom of the feed hopper, which is fitted with an agitator. It is intended for feeding pasty materials and can handle calcium carbonate containing 35 per cent water with no difficulty. The feed hopper itself is water jacketed for cooling or heating. The feed rotor has a hollow shaft to which vanes are welded parallel to its axis. A heating or cooling medium can thus be circulated through it to prevent material from sticking.

Increasingly high vacuums are being required. Designers have, as a result, produced a commercial pump capable of producing a vacuum within 100 microns (0.004 in.) of absolute, and can provide one on special order which will produce a vacuum within 10 microns of absolute. The units are of the oil-sealed type, and have cooling coils incorporated in the oil reservoir and a water jacket around the cylinder to aid in maintaining the vacuum. The unit is built of close-grain cast iron, with bronze bearings in the smaller sizes and full roller bearings in larger pumps. The pump shaft is of chrome steel.

One line of submerged lead centrifugal pumps eliminates the stuffing box by the use of a vertical boot around the drive shaft. A type of heat ex-

changer is a modification of the American Tubeflo types, substituting tubes for cast construction. Four tubes are placed parallel and expanded into numerous plates of metal arranged in close proximity. Return bends at one end connect the two hot-fluid and the two cold-fluid passages, while nozzles at the other end serve to introduce and remove the fluids.

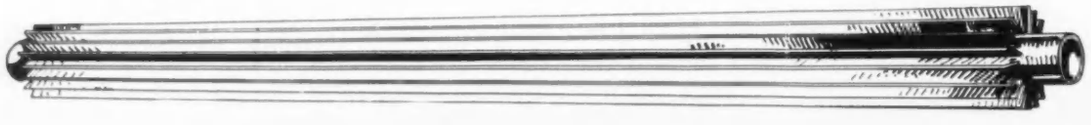
A unique form of heat exchanger, the "Stamsvik," is built like a filter press and consists of recessed plates of any suitable metal clamped together by means of through bolts and generally sealed with gaskets. Openings through the plates are so arranged that the assembled exchanger consists of a number of thin, substantially circular chambers, separated by thin metal diaphragms. Alternate chambers are in either the hot or cold fluid circuit. Any number of units may be used to obtain the required length of exchanger. The material flows in approximately a straight line and about 90 per cent of the joints necessary in tube and shell design are eliminated. A third type of heat exchanger combines the jet and barometric types to produce a condenser requiring no air pump.

A radically different form of clarifying filter, known as the Laughlin clarifying tank, resembles a thickener in that settled solids are removed to the tank discharge by means of a rake; but the clarified effluent must pass upward under hydrostatic head through an annular bed of magnetite before it reaches the overflow launder. A rotating cleaning mechanism travels around the magnetite bed continuously. Through the action of an intermittently energized electro-magnet, the magnetite particles are lifted periodically, and as they drop through the upward flow of water, dirt is flushed off. The wash water is returned to the intake of the clarifier or it may be discharged to the sewer. In a modified form, the rake and cleaning mechanism are eliminated, but the magnetite filter bed is retained. A cone bottom discharges settled solids through a valve consisting of two fluted rollers in close contact with the casing.

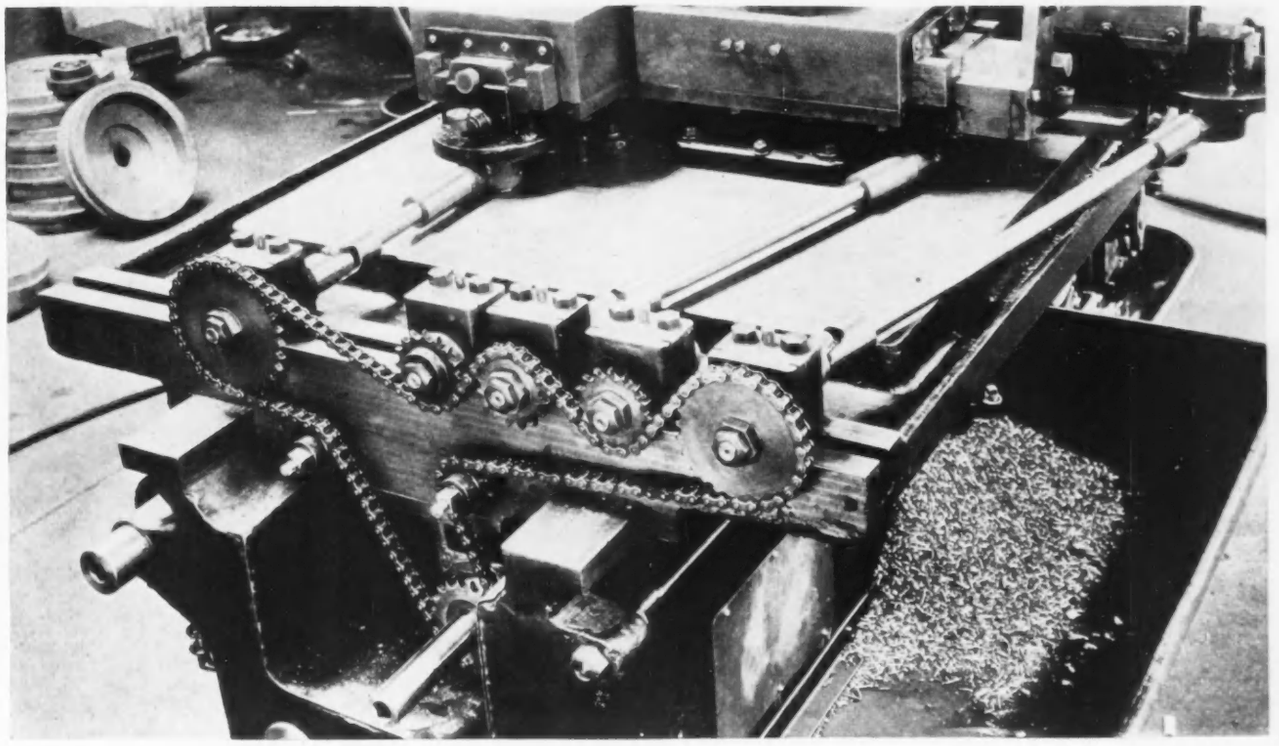
Sifting of numerous materials in conditioned air which may be cleaned, heated, cooled, dried or humidified, is possible with a new air-conditioned sifter which incorporates the necessary air-conditioning and dust-separation equipment and makes use of a rotating cylindrical screening element. Another sifter shown by this concern consists of a single- or multi-deck screen supported on a mechanism which imparts a rapid rotary screening motion to it. Construction is dustproof and units require only 1/20 hp. A high-speed "turbine" sifter, known as the "Blutergess," has been introduced from France. It differs markedly from those produced in this country, consisting of a vertical shaft carrying two turbine-like distributors which throw the material forcibly against encircling screens. Floor space required is exceptionally small. The blade profile forces every particle of the material to strike the screens at a constant angle. Screens are set vertically to minimize wear and are of phosphor bronze, brass, or steel. They are mounted on high steel frames, held in position by steel straps, and can be changed easily by loosening one knurled screw. Any mesh to 300 or even finer may be obtained with coarse cloths because of the angle at which the material strikes the screen. Thus, in effect, a coarse screen prevents clogging and yet does finer sifting. No air separation is used in the unit, nor are brushes incorporated.

An air-operated cycle controller for opening and closing valves and other apparatus uses a clock-driven cam operating a series of air valves. Another unique type of instrument is a "flame analyzer" used to control the heating effect of gases. The instrument consist of a means of supplying gas at a constant rate to a burner which can be very accurately adjusted for flame height. Four small thermocouple junctions are supported at different points in the flame and these are connected so that each pair is in series and the two pairs oppose each other. When flame characteristics are correct, net voltage generated is zero. Any deviation in flame characteristics will show fluctuations on a permanent record.

An automatic screw-feed device, intended for automatic weighing of cement to be shipped in bulk, avoids the difficulties inherent in weighing by ordinary hopper weighers which results from the packing and air pocketing in the hopper. A main screw delivers approximately 90 per cent of the desired load to a hopper whereupon an auxiliary screw delivers the balance more slowly until the scale mechanism causes cut-off.



Tube element of a G-Fin gas cooler utilizing lengthwise fins set in slots and crimped fast around the periphery of the tube instead of the usual circular fins



Roller Chain Drives
IN THEORY AND PRACTICE

By G. M. BARTLETT

Professor of Machine Design, Purdue University
Consulting Engineer, Diamond Chain & Manufacturing Company

The second article of a series. The first appeared in the April number.

IN A CHAIN DRIVE the angular velocity ratio is constant for entire revolutions of the sprocket, and for parts of a revolution corresponding to the passage of a whole number of teeth. But there is usually a slight deviation from uniformity during the passage of a single tooth, the one exception to this being the case where the velocity ratio is 1 to 1, and the center distance is an exact multiple of the pitch.

A chain drive has been likened to a pair of spur gears meshing with an endless flexible rack, but the analogy is more apparent than real. No means have yet been found by which the action of a rigid rack with a spur gear can be imitated by a flexible rack which is to wrap itself around the gear after a theoretically correct engagement with the teeth. The reason is that for a correct rack action the pitch of the rack must be equal to the circular pitch of the gear, while for a correct wrapping of the rack about the wheel its pitch must be equal to the chordal pitch of the gear. Two toothed wheels of the same circular pitch but of different sizes cannot have the same chordal pitch; hence the same flexible rack, with links of a definite pitch, cannot wrap correctly about the circumference of both wheels.

Neither is the action of a chain and sprocket like that of an ordinary belt and pulley. But if we conceive the pulley to be a polygon with as many sides as there are teeth in the sprocket, the comparison will be more nearly correct. The action of a chain as it travels over a sprocket may be compared with that of a non-slippable belt traveling over a prism. The more sides in the prism, the smoother the action. This is the reason why the use of wheels having as large a number of teeth as possible is desirable.

The conditions which cause fluctuations in angular velocity are illustrated in Fig. 1, in which a 6-tooth sprocket drives a 9-tooth sprocket. In Fig. 1A the tangential distance is equal to $5\frac{1}{2}$ pitches, and the center distance is such that when the driving strand of the chain is at its nearest approach to the center of one sprocket it is the farthest from the center of the other. If we assume the driving sprocket to be turning uniformly, it is evident that the angular velocity ratio, instead of being N_2/N_1 or 9/6 is:

$$\frac{R_2}{R_1 \cos\left(\frac{180}{N_1}\right)} = \frac{P}{2 \sin\left(\frac{180}{N_2}\right)} \div \frac{P \cos\left(\frac{180}{N_1}\right)}{2 \sin\left(\frac{180}{N_1}\right)}$$

or velocity ratio equals $\dfrac{\tan\left(\frac{180}{N_1}\right)}{\sin\left(\frac{180}{N_2}\right)} = 1.68$

When the chain has moved through a half pitch conditions are reversed and the angular velocity ratio is:

$$\frac{R_2 \cos\left(\frac{180}{N_2}\right)}{R_1} = \frac{P\cos\left(\frac{180}{N_2}\right)}{2\sin\left(\frac{180}{N_1}\right)} \div \frac{P}{2\sin\frac{180}{N_1}}$$

$$= \frac{\sin\left(\frac{180}{N_1}\right)}{\tan\left(\frac{180}{N_2}\right)} = 1.374$$

The maximum velocity of the driven wheel is thus:

$$100\left[\frac{1}{\cos\left(\frac{180}{N_2}\right)\left(\cos\frac{180}{N_1}\right)} - 1\right] = 22.9 \text{ per cent}$$

greater than the minimum.

This variation in angular velocity can be reduced greatly by adjusting the center distance so that the tangential distance shall be an exact multiple of the pitch as in Fig. 1B, instead of an odd multiple of half the pitch.

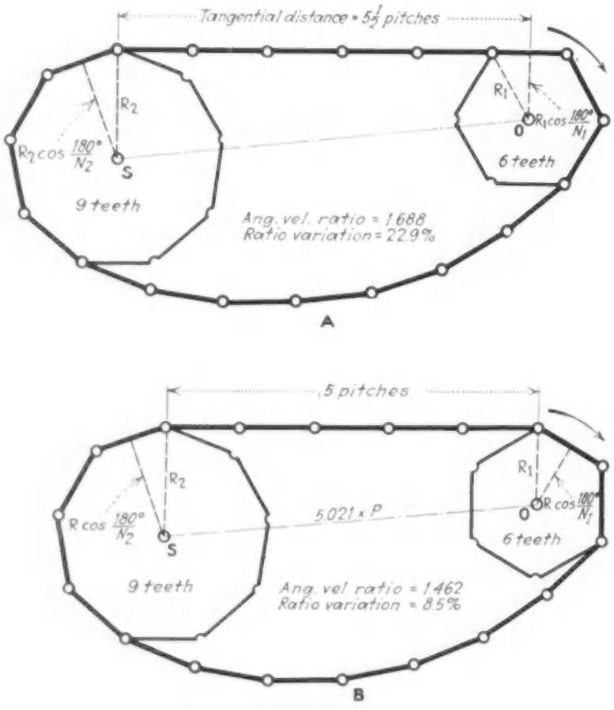


Fig. 1—By making the tangential distance equal to an even number of pitches, as at *B*, the velocity ratio variation is reduced from 22.9 to 8.5 per cent

Here the angular velocity ratio varies between $\dfrac{R_2}{R_1}$ and $\dfrac{\sin\left(\frac{180}{N_1}\right)}{\sin\left(\frac{180}{N_2}\right)}$.

The maximum velocity of the driving wheel is thus

$$100\left[\frac{\cos\left(\frac{180}{N_2}\right)}{\cos\left(\frac{180}{N_1}\right)} - 1\right]$$ or 8.5 per cent greater than the minimum

Thus, by changing the center distance an amount equal to half the pitch, the velocity fluctuations have been reduced from 22.9 to 8.5 per cent.

It must be borne in mind that Fig. 1 illustrates a very unusual chain drive, the number of teeth being less than one-third the number usually used. The table shows

Per Cent Variations in Angular Velocity with Various Combinations of Teeth

No. of Teeth on Driven	Teeth on Driver 6	9	14	21	30	45
6	00.0	...	...	...	...	...
	33.3	...	...	...	...	...
9	8.5	00.0	...	...	...	...
	22.9	13.2	...	...	...	...
14	12.6	3.7	0.0	...	...	...
	18.4	9.1	5.2	...	...	...
21	14.3	5.3	1.5	0.0	...	...
	16.6	7.5	3.6	2.0	...	...
30	14.8	5.8	2.0	0.4	0.0	...
	16.1	7.0	3.1	1.5	1.1	...
45	15.2	6.2	2.3	0.7	0.3	0.0
	15.7	6.7	2.8	1.3	0.8	0.5

Upper figures correspond to tangential distances that are an exact multiple of the pitch; lower figures, for an odd multiple of the half pitch

variations in angular velocity for various combinations of teeth, and indicates the advantage of using sprockets with a large number of teeth, as well as the effect of an adjustment of center distance. The upper figures give the percentage of variation in the angular velocity of the driven wheel when the tangential distance is an exact multiple of the pitch. The lower figures give the percentage of variation when the tangential distance is an odd multiple of half the pitch.

Assume, however, that the weight of each sprocket with its attached masses is sufficient to maintain an approximately uniform angular velocity despite the tendency to transmit a variable angular velocity. The result is that the chain tends to travel too fast during a part of the time and too slow during the rest of the time. Uniformity of motion may be attained under these conditions through the medium of elasticity in the chain, or spring cushions in the sprockets, or non-rigid connection between the sprocket bearings, but most important of all by the elastic compression of the oil films between pins, bushings, rollers and sprocket teeth.

Careful tests made in England have shown that the wavy path of pin centers along the driving strand of a dry chain changes into a path almost absolutely straight by the introduction of a proper supply of lubricant. Furthermore, calculations show that in the average chain drive the amount of elastic stretch required is only a few thousands of an inch.

Chain elongation, or stretch, is caused by wear between the pins and bushings which increases the size of the holes and reduces the size of the pins. This causes an increase in the pitch distance between the roller centers of each pin link, but does not affect the pitch of the roller links.

As soon as the forward roller of a pin link seats itself between the teeth of the driving sprocket, the pin link begins to turn about the forward pin until the next roller has seated itself. The angle of bend is $360/N_2$ deg. During this turn the pressure between the pin

and bushing is equal to the whole load on the chain, but there is no wear between the bushing and the roller, nor between the roller and the sprocket. At this instant the next link which is a roller link, begins to turn about the rear pin. During this turn the average pressure between the rear pin and its bushing is less than the load on the chain, and there is definite wear between the bushing and roller.

As the same links leave the driven sprocket the reverse conditions hold. It is evident that if the driving sprocket is smaller than the driven sprocket, the forward pin of the pink link will wear more rapidly than the rear pin, and if the driving sprocket is the larger of the two, the rear pin will wear more rapidly.

Extensive study of this subject has shown further that elongation of a chain caused by wear between pins and bushings becomes more rapid when the load or the sprocket speed is increased, or the chain length is shortened, or when the width of the chain is decreased.

The maximum elongation that can take place in a chain before it is unfit for futher use varies according to the number of teeth on the larger sprocket, and the character of the drive. In some cases chains are not discarded until they have stretched to the extent of 3 per cent or more of their original length, and in others they are considered unfit for use before they have stretched half that amount. An elongated chain acts at higher points on the teeth, depending upon their number. With a chain of 3 per cent elongation and a 60-tooth sprocket, for example, the roller centers are acting as far out as the outside circle of the sprocket. If we consider this the limit for a satisfactory drive, the maximum elongation per foot would be 0.36 in. for 60 teeth, 0.31 in. for 70 teeth, 0.27 in. for 80 teeth, 0.24 in. for 90 teeth, 0.18 in. for 100 teeth, and 0.17 in. for 125 teeth.

In a new chain drive in which the pitch of the chain is the same as that of the sprocket, all rollers are seated at the bottoms of the spaces between the sprocket teeth. With an elongated chain, the rollers are forced to operate at points further from the center, but there is always one roller that occupies a position at the bottom of the tooth gap, as at W, Fig. 2. If the tension in the two strands of the chain were equal, the position of W would be midway between the approaching and the departing roller, but when the tensions are unequal W moves toward the slack strand.

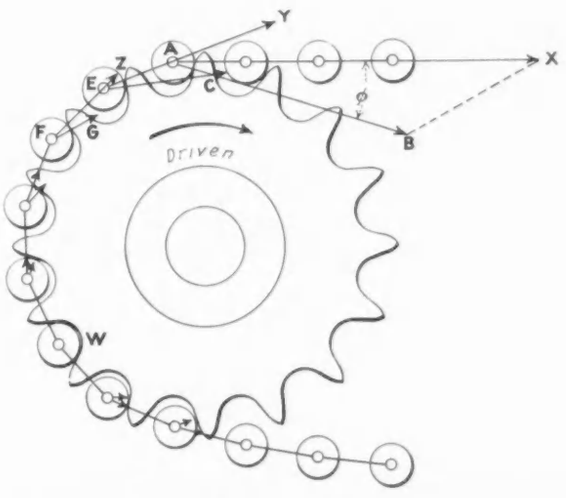


Fig. 2—Action of an elongated chain over a sprocket. Roller *W* is the only one that bottoms in the tooth space

Considering the first active roller A, there are three forces acting upon it, namely: AX which is equal to the tension T of the chain; BA which is normal to the tooth curve at the point of contact with the roller; and EY which acts along the center line of the link AE. By drawing BX parallel to EY, we have the force diagram AXB, in which XB is the tension in the first link AE, and BA is the pressure between the roller and the tooth. The angle XAB is the *pressure angle*. The link to the right of A has just completed its turning motion about the pin at A, and during the time of that motion the tension in the link has not changed.

If it is a *pin* link, the forward pin supports a bearing pressure equal to AX during the entire bending motion If it is a *roller* link, the pin is attached to the pin link AE, and hence during the bending the pin pressure has decreased from AX to BX and the *average* pressure is about one half the sum.

If N is the number of teeth, ϕ the pressure angle, and T the tension in the tight strand of the chain, then the pressure on the first tooth is:

$$AB = \frac{T \sin\left(\frac{360}{N}\right)}{\sin\left(\frac{360}{N} + \phi\right)} \qquad (1)$$

The tension in the first link AE is:

$$T' = BX = \frac{T \sin\phi}{\sin\left(\frac{360}{N} + \phi\right)} \qquad (2)$$

The average pin pressure on the rear pin of a pin link during the flexing of the link is:

$$\frac{T + T'}{2} = \frac{T}{2}\left[1 + \frac{\sin\phi}{\sin\left(\frac{360}{N} + \phi\right)}\right]$$

By laying out the force triangles successively for each link, the tooth pressures and link tensions can be determined for all of the links as far as the "bedded" roller W where the tooth pressures on the two sides of the roller, and the tensions in the two adjacent links are equal.

The above discussion shows how the new standard sprocket tooth design automatically compensates for chain elongation, how the load is distributed (unequally) among a number of the teeth, how each link and each tooth takes its load gradually and gives it up gradually.

As to the much talked of "rolling action over the sprocket teeth," any one who will take the trouble to wrap a chain slowly about a sprocket and carefully observe the approach and departure of the rollers will note that the rollers do not roll over the sprocket teeth at these times. Where the chain is elongated there is a slight rolling action between the positions at A and at W, Fig. 2, but remembering that the figure is greatly exaggerated, the amount of this rolling is insignificant. Each bushing, however, turns within its roller an amount equal to $360/N$ deg. every time it passes around a sprocket with N teeth. The forward bushing on a roller link turns in the roller during approach and the rear bushing turns during departure. Thus the hole in the roller receives uniform wear in all parts throughout the life of the chain. The rate at which the rollers turn over their bushings is theoretically equal to $\left(\frac{S_1}{N_1} + \frac{S_2}{N_2}\right)$ turns per minute, where S_1 and S_2 are the sprocket speeds and N_1 and N_2 are the teeth in the sprockets.

Matching Modern Architecture

the design of one of the "modern conveniences"

By J. O. CADIEUX

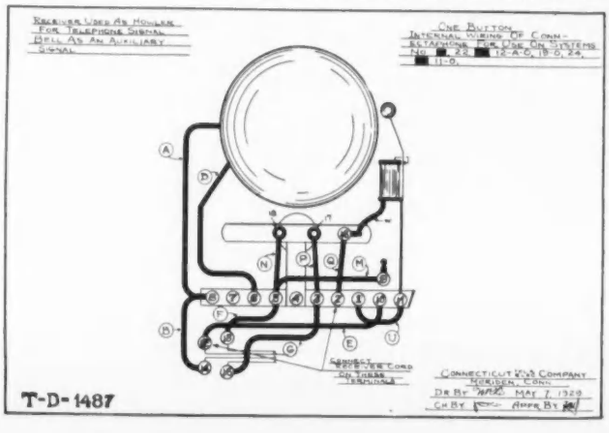
Chief Engineer, Connecticut Telephone & Electric Corporation

THE apartment house telephone in principle may be considered as an outgrowth of the older intercommunicating factory telephone, but as a design development problem it constitutes a thing apart. New factors and a different kind of consumer had to be considered. In the case of the Connectaphone the engineering development was carried on over a period of four years, even though the company had as background an experience of thirty years in intercommunicating telephone systems.

When during the period of extensive apartment house construction about five years ago, it was decided to bring out a telephone that would meet the requirements of these modern, well-equipped buildings, the engineers of the company determined to strike away from beaten paths and redesign "from the ground up." All of the complaints, criticisms, and suggestions relating to the old standard telephones were considered, and the preliminary suggested models were discussed with the architects of the building. This process meant much experimentation, and the construction of many models before anything was put into the shop. The result, however, was that a model was finally developed to such a state of refinement that it received the approval and acceptance of a number of important specifying architects, even before any expense was incurred in production activities.

Some of the general requirements as gathered in the field were: The instrument must be an integral part of the building and must "look modern," in keeping with the newer buildings; it must be dust-proof and tinkerproof; it must be capable of easy removal from the wall to permit painting, plastering, or papering; operating and signalling current must be taken from regular house circuits in order to save battery replacement troubles; a positive signal must be provided on the suite phone to indicate that the calling party

DIAGRAMS are furnished by the engineering department to every dealer to enable him to make bus-bar changes to suit any system

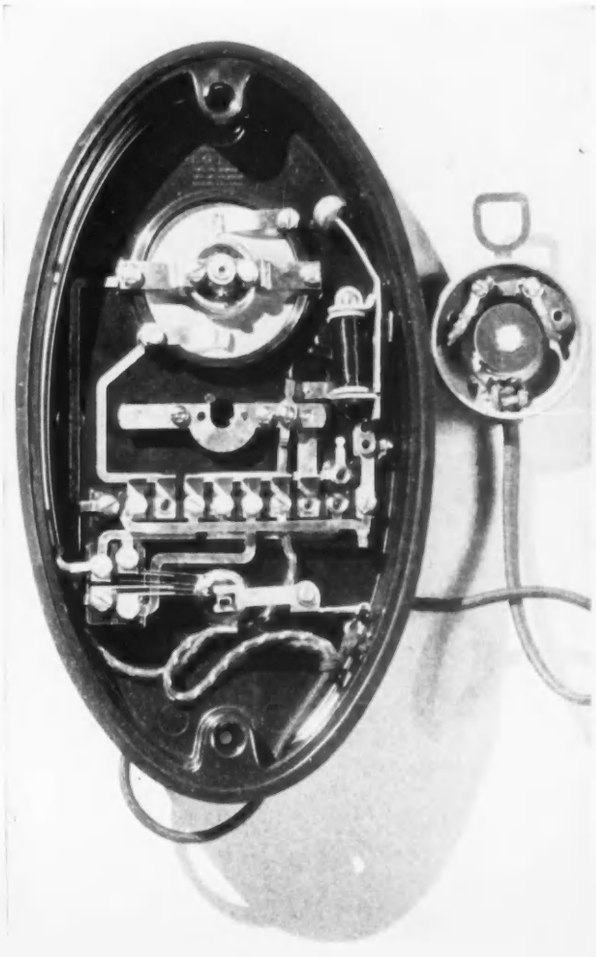


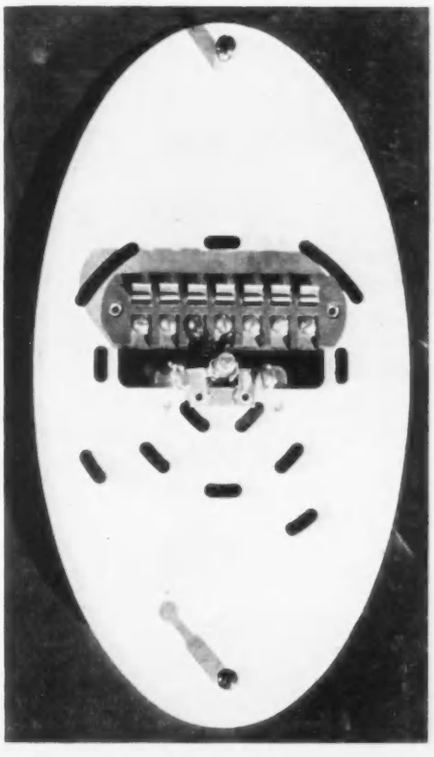
has entered the vestibule door; for school use the instrument must be positively chalkproof.

From the standpoint of the dealer an instrument was desired that could be adapted easily to various different house systems, thereby avoiding the necessity of stocking a large variety of sets. From the standpoint of production in the shop, all parts were required to be made either in presses or on the screw machine for economy in quantity production, and rapid economical assembly was also desired. A description of one telephone model will show how these requirements were met by the designer.

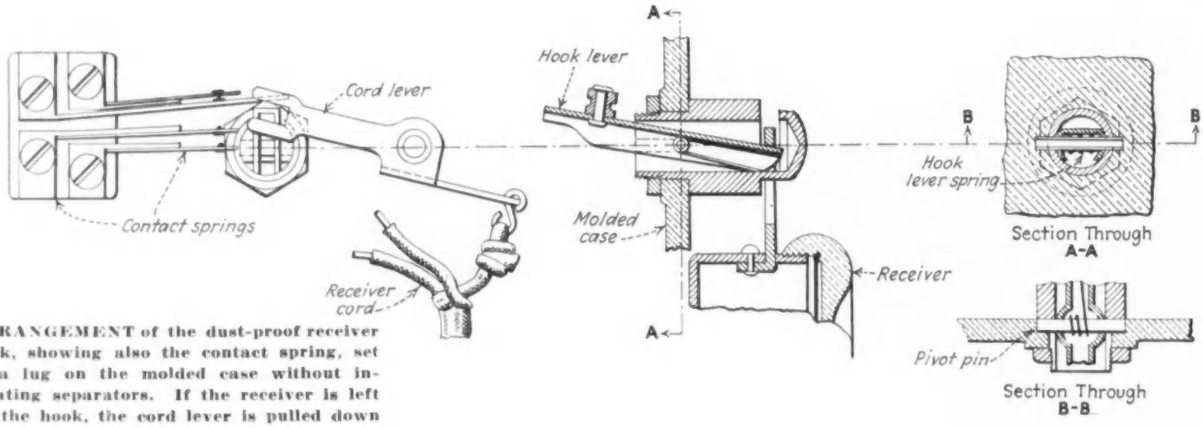
The body design of the Connectaphone resulted from consultation with designing architects. It is elliptical in form with a "modern" severity of line, and hugs the wall closely as compared with the ordinary old-style wall-box telephone. To obtain the closeness required without sinking into the wall was an engineering feat, and the result is shown in the accompanying illustration of the dismounted instrument. The body was made of molded Bakelite, which because of its high insulating characteristics, required no shielding from contact with the circuit metals, thus saving space as well as work and material. All connections were made in the form of flat bus bars stamped from sheet metal, which besides saving space made a neater arrangement and eliminated wiring troubles and soldering. The transmitter mouthpiece and holder were made integral with the body and sunk into it. Then, by designing the bell, or gong, to fit around the transmitter no space was lost in the instrument. The ringer was made with one powerful magnet, instead of the more bulky double-pole magnet, and placed directly in line with the bus-bar circuits to conserve space. A lug molded intact with the body receives the several contact springs without further insulation and thus saves the usual insulating block and separators.

The back plate of the instrument is of heavy sheet steel, cadmium plated, with all of the line connections on one insulating block, which is of cold-molded Cetec. The line plug contacts are heavy gage bronze spring that automatically form good electrical contact with the bronze line-jack strips. The bus bars are of sheet brass cadmium plated, and they form a rigid electrical construction without the use of wires or solder. To "rewire" the telephone for any other type of system, it is only necessary to install the bus bars designated for the given system. The brass inserts to which the bus bars are attached are molded into the case. The button rings on the body are molded in such a manner that they can be left as ornaments only, or broken through to receive one, two, or three buttons, or two buttons





INSIDE arrangement of the telephone, showing also the receiver with magnet attached to the steel shell as part of the talking circuit. Wiring in the telephone case is eliminated by a system of bus bars fastened by screws to inserts molded in the Bakelite case. The wall plate, shown at the right, contains the line contact springs in a molded block



ARRANGEMENT of the dust-proof receiver hook, showing also the contact spring, set in a lug on the molded case without insulating separators. If the receiver is left off the hook, the cord lever is pulled down and the current cut off

and a signal light. The buttons are molded Bakelite with enamelled designations.

In studying the problems from the standpoint of house installation some means had to be considered for providing for the many types of outlet boxes employed by electrical contractors in various parts of the country. This was taken care of by punching slots in the back plate so arranged as to fit all standard outlet boxes. These are shown in the illustration. Thus, no drilling work is left to the installer, and the extra slots naturally do not show when the case is in place. This arrangement is also formed to permit the setting of the instrument in a square position on the wall even when the outlet box has been badly installed.

To provide for installations where there would be exposed wiring, as in factories, four spots on the oval back plate are sheared so that in case of necessity the installer can bend them back and form four lugs, or feet, to keep the plate away from the wall and allow for the passing of the line wires.

Standard instruction sheets were made up in the engineering department, and a file of blueprints is provided as a part of the equipment of each dealer so that a small stock of bus bars is all that is required for different systems instead of having to stock a large number of sets of telephones. All screws used throughout the instrument are commercial standards.

The transmitter is ingeniously arranged to save space and to eliminate the ordinary type of ugly mouthpiece. The mouthpiece and the diaphragm container are molded as an integral part of the telephone body, and the trimmed aluminum diaphragm is held on by two bronze springs. The transmitter button is of the granular carbon class, and is held in place by a straight bridge which in turn acts as support for the gong. This gong is drawn bell metal and is cadmium plated. Access to the transmitter diaphragm and button is obtained by simply removing the two screws that hold the gong. The gong hammer is of cold-rolled iron tubing with a fiber core.

Instead of the usual non-ferrous or dielectric material in the receiver case, the case is made of pressed steel and forms part of the magnetic circuit while the receiver is energized. The receiver magnet core is of basic iron. The receiver while hung up is used as a means of signaling by the use of a transformer connected to 110 volt, 60 cycle circuit on the primary. The secondary delivers 12 to 14 volts a.c. to the receiver, giving a signal similar to that of a miniature automobile horn. Lifting the receiver off the hook switch throws the receiver into the talking circuit, making available the direct-current battery current for talking. The battery current is thus conserved for the talking only.

A feature that was especially desired for apartment house use was the signalling light which flashes when the party at the outer door has entered the vestibule. The light is a specially designed bulb which is inserted between two bronze jack springs on the back plate. The bullseye is located in the center button frame on the body and is of molded glass.

The body of the telephone is made up of dark-brown Bakelite, molded to a matte finish with polished edges. The receiver cap is of the same material, and the steel receiver case is lacquered to match. When the finish of the apartment house demands other colors, sprayed lacquer in any desired color is used on the case, lacquer adhering very well to the phenol molding material.

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STRESSES IN FILLETS

Economy of material has increased apparent working stresses, making necessary greater attention to calculation of concentrated stresses

By E. F. GARNER

Assistant Professor of Machine Design, Cornell University

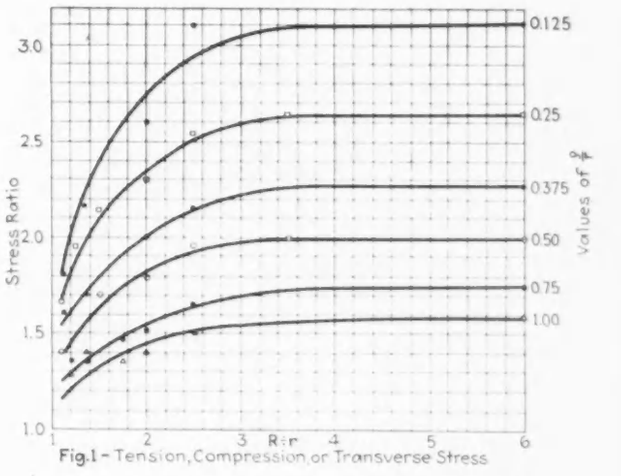


Fig. 1 – Tension, Compression or Transverse Stress

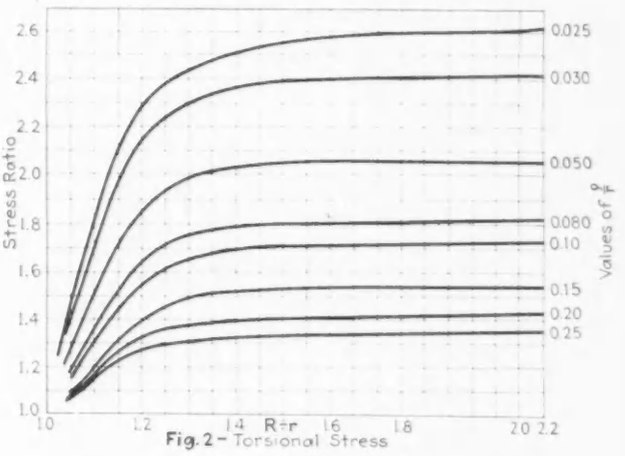


Fig. 2 – Torsional Stress

Fig. 1—Ratio of concentrated stress to normal tension, compression, or transverse stress
Fig. 2—Ratio of concentrated to normal stress when connected members are subjected to torsion

IT IS well known that rapid changes of section such as are produced by small fillets induce high stress concentration in and around the fillets when the fillet-connected members are subjected to loading of any kind. These high stress concentrations are very undesirable in machine members, especially when the members are subjected to reversals of stress.

General analytical expressions for finding the stress concentrations in fillets have been formulated, but these expressions are so complicated that very few attempts are made to use them in actual design work.

With the increased tendency to decrease the sizes and weights of machine parts in the interest of economy of material, the apparent working stresses have been increased and the problem of stress concentration becomes of great practical importance, so that its effect must be considered in actual design.

The stress concentration factors for fillets in bending for several sizes of fillets and several ratios of fillet-connected rectangular members have been found experimentally by S. Timoshenko, and W. Dietz (see Transactions, A. S. M. E., Vol. 47-1925), and there is no reason to believe that these factors will not apply to circular sections in bending or to either circular or rectangular sections in direct tension or compression as well, if the material is homogeneous, isotropic and perfectly elastic, as may be said of steel if it is not stressed beyond the elastic limit.

The stress concentration factors for fillets in torsion for several sizes of fillets and several ratios of fillet-connected circular shafts have been determined experimenta'ly by Lydik S. Jacobsen (see Transactions A.S.M.E., Vol. 47-1925) by means of an electrical analogy.

An analysis of the data from these experiments reveals that only two variables are involved, namely, the ratio of the radius of the fillet to the radius or depth of the smaller section and the ratio of the radii or depths of the fillet-connected members. An inspection of the curves from these experiments shows that the stress concentration increases with a decrease in fillet size for a constant ratio of radii or depths of fillet-connected members, very rapidly at first and then more slowly until a ratio is reached beyond which there is no increase in stress.

It is not believed that the increase in stress for a given size of fillet in bending follows a straight line law up to a certain ratio of depths of members and then suddenly becomes uniform for an increase in the ratio, as is indicated by Timoshenko in a plot of the original data. It is plausible to believe that the variation in stress concentration for fillets in bending follows the same general

Preprints of this article are being distributed among the members of the "Clearing House for Machine Design Data," an organization of the professors of machine design headed by Prof. Frank L. Eidmann of Columbia University.

$\frac{\rho}{r}$ \ $\frac{R}{r}$	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	Multiplier
0.125	2.40 / 1.35	2.75 / 1.38	2.95 / 1.39	3.06 / 1.39	3.10 / 1.39	3.11 / 1.39	3.11 / 1.39	3.12 / 1.395	1.39
0.250	2.10 / 1.18	2.35 / 1.19	2.52 / 1.19	2.61 / 1.19	2.64 / 1.20	2.65 / 1.19	2.65 / 1.19	2.66 / 1.19	1.19
0.375	1.80 / 1.01	2.00 / 1.01	2.15 / 1.02	2.23 / 1.02	2.27 / 1.02	2.28 / 1.02	2.28 / 1.02	2.28 / 1.02	1.02
0.50	1.64 / 0.92	1.83 / 0.92	1.93 / 0.91	1.98 / 0.91	2.00 / 0.90	2.00 / 0.90	2.00 / 0.90	2.00 / 0.90	0.905
0.75	1.42 / 0.80	1.55 / 0.78	1.63 / 0.77	1.70 / 0.78	1.73 / 0.78	1.75 / 0.785	1.76 / 0.79	1.76 / 0.79	0.785
1.00	1.33 / 0.75	1.45 / 0.73	1.52 / 0.72	1.56 / 0.71	1.57 / 0.71	1.58 / 0.71	1.59 / 0.71	1.60 / 0.72	0.720
Sum	10.69	11.93	12.70	13.14	13.31	13.37	13.39	13.42	
Avg.	1.78	1.99	2.12	2.19	2.22	2.23-	2.23	2.23+	

Table 1—Stress concentration factors for tension, compression or transverse stress corresponding to values of ratio of depth or radii of connected members and ratio of fillet radius to radius of smaller section

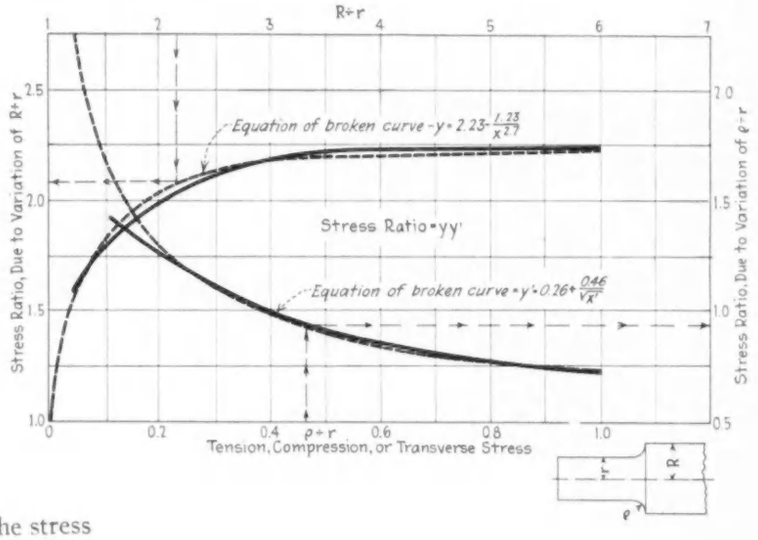

R÷r
Stress Ratio, Due to Variation of R÷r
Stress Ratio, Due to Variation of ρ÷r
Equation of broken curve - y = 2.23 - 1.23/x^2.7
Stress Ratio = yy'
Equation of broken curve = y' = 0.26 + 0.46/√x
ρ÷r
Tension, Compression, or Transverse Stress
R
r
ρ

Fig. 3—Average variation of stress concentration with change in ratio of fillet radius to radius or depth of the smaller member and average variation of stress concentration with variation in ratio of depth or radii of connected members, for tension, compression, or transverse stress

law as that for fillets in torsion, a plot of which is shown in Fig. 2. A replot of the curves for fillets in bending is given in Fig. 1.

An inspection of this replot reveals a family of curves from which it is seen that the stress concentrations are functions of the ratio of the radius of the fillet to the radius or depth of the small member and the ratio of the radius or depth of large member to the radius or depth of the smaller of the two members that are joined.

If for the several ratios of R/r, the values of the stress concentration factors for tension, compression, or transverse stress are tabulated for the several fillet ratios, as in Table I, the average values gives a curve, as shown in Fig. 3, which represents the variation of stress concentration with change in ratio of R/r. Similarly Table I and Fig. 4 show the same conditions for torsional stress.

If for each of the several fillet ratios the values of the stress concentration factors be divided by the average stress concentration factor, it is seen that the quotient is sensibly a constant quantity for any given value of fillet ratio. A plot of the values for the several fillet ratios gives a curve as in Fig. 3, which represents the variation of stress concentration with change in the ratio of fillet radius to the radius of the smaller member.

Equations were found that fairly well fitted these two sets of curves, the full line curves being a plot of the transformed experimental data and the broken line curve representing the derived equation.

The equations of these two curves involving the two variables $\rho + r$ and R/r, when multiplied together will give an equation for the stress concentration factor. The stress concentration factor is given in terms of the stress in a straight member having the same radius or depth as that of the smaller member.

For transverse, tension, or compression loading, the stress concentration factor is

$$K = \left[0.26 + \frac{0.46}{\sqrt{\rho \div r}}\right]\left[2.23 - \frac{1.23}{(R \div r)^{2.7}}\right]$$

As this equation involves only ratios, the system of measurement used is immaterial.

In the foregoing equation

ρ = radius of fillet
r = half depth of small member
R = half depth of large member

For torsion loading the stress concentration factor is

$$K' = \left(0.43 + \frac{0.15}{\sqrt{\rho \div r}}\right)\left(1.88 - \frac{0.88}{(R \div r)^{3}}\right)$$

where

ρ = radius of fillet
r = radius of small member
R = radius of large member

The maximum stress in the fillet is about 15 deg. from the beginning of the fillet, measured from the small member, for both transverse and for torsion loading. Therefore for combined bending and torsion the fillet stress for each loading may be determined separately and combined to give the maximum tensile or compressive stress or to give the maximum shear stress.

Concentrated stresses in fillets may cause the birth of "fatigue cracks," particularly in brittle materials. Even low-carbon steels subjected to vibratory stresses may fail because of high stresses in small fillets or sharp corners

Table 2—Stress concentration for torsional stress corresponding to values of ratio of depth or radii of connected members and ratio of fillet radius to radius or depth of smaller section

$\frac{\rho}{r}$ \ $\frac{R}{r}$	1.1	1.2	1.3	1.4	1.6	1.8	2.0	2.2	Multiplier
0.025	1.82 / 1.31	2.28 / 1.35	2.44 / 1.36	2.52 / 1.38	2.58 / 1.39	2.61 / 1.395	2.62 / 1.39	2.62 / 1.39	1.37
0.03	1.70 / 1.22	2.14 / 1.27	2.30 / 1.285	2.37 / 1.29	2.41 / 1.295	2.42 / 1.29	2.43 / 1.29	2.43 / 1.29	1.285
0.05	1.50 / 1.08	1.85 / 1.10	1.98 / 1.11	2.03 / 1.11	2.07 / 1.12	2.07 / 1.10	2.07 / 1.10	2.07 / 1.10	1.10
0.08	1.34 / 0.965	1.65 / 0.98	1.76 / 0.98	1.78 / 0.973	1.81 / 0.972	1.82 / 0.973	1.83 / 0.973	1.83 / 0.973	0.975
0.10	1.29 / 0.93	1.55 / 0.92	1.65 / 0.922	1.70 / 0.93	1.72 / 0.925	1.73 / 0.925	1.73 / 0.92	1.73 / 0.92	0.925
0.15	1.19 / 0.857	1.39 / 0.825	1.49 / 0.832	1.52 / 0.83	1.54 / 0.828	1.54 / 0.823	1.54 / 0.82	1.54 / 0.82	0.825
0.20	1.17 / 0.84	1.32 / 0.79	1.37 / 0.765	1.39 / 0.765	1.41 / 0.758	1.42 / 0.758	1.43 / 0.76	1.43 / 0.76	0.76
0.25	1.16 / 0.835	1.27 / 0.75	1.30 / 0.726	1.32 / 0.72	1.33 / 0.715	1.34 / 0.716	1.36 / 0.723	1.36 / 0.723	0.72
Sum	11.17	13.45	14.29	14.63	14.87	14.95	15.01	15.01	
Avg.	1.40	1.685	1.788	1.83	1.86	1.87	1.88	1.88	

Fig. 4—Average variation of stress concentration with change in ratio of fillet radius to radius or depth of the smaller member and variation of stress concentration with variation in ratio of depth or radii of connected members for torsional stress

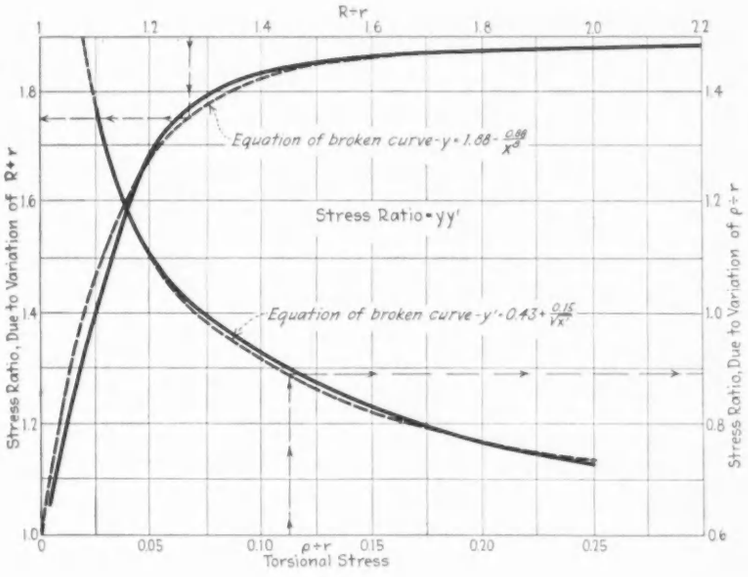
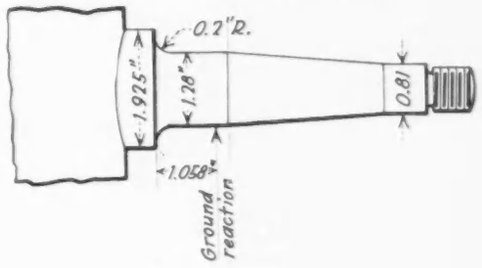


Fig. 5—Automobile front wheel spindle for which maximum stress in fillet at the shoulder was calculated



Since, in any case, the maximum stress in the fillet is highly localized, this stress may easily exceed the yield point stress of the material without showing any permanent deformation of the member as a whole. If the material is ductile a rearrangement of the stress distribution may take place by a change of radius of fillet, but if the material is very hard, under repeated stressing or impact loading, cracks may occur in the highly stressed portion of the fillets and the endurance limit be thereby greatly reduced.

As an example of the application of these formulas we will take the front wheel spindle of an automobile that was used for a number of years and proved to be satisfactory.

Road weight of four door sedan and five passengers = 3750 lb.
Weight on front wheels 0.4×3750 = 1500 lb.
Effective radius of tire = $14\frac{1}{4}$ in.
Coefficient of tire friction = 0.6
Minimum yield point of material (S.A.E. No. 3135) = 110,000 lb. per sq.in.

In Fig. 5 are shown the dimensions of the spindle. The maximum bending movement in the spindle occurs when the car is turning a corner at such a speed that as a result of the centrifugal force it is at the point of impending overturn. Then the entire weight of the car will be concentrated on one of the front wheels, in addition to which there will be a side thrust on that wheel.

Weight on front wheel spindle = 1500 lb.
Side thrust at ground, 0.6×1500 = 900 lb.
$M = (900 \times 14.25) - (1500 \times 1.058)$ = 11,200 lb. in approx.

Maximum bending stress in straight shaft equals

$$S_t = \frac{32M}{\pi d^3} = \frac{32 \times 11{,}200}{\pi \times 1.28^3} = 55{,}000 \text{ lb. per sq.in.}$$

$$\rho \div r = \frac{0.4}{1.28} = 0.312;$$

$$R \div r = \frac{1.925}{1.28} = 1.5$$

$$K = \left(0.26 + \frac{0.46}{\sqrt{0.312}}\right)\left(2.23 - \frac{1.23}{1.5^{2.7}}\right) = 1.97$$

Maximum stress in fillet, $KS_t = 1.97 \times 55{,}000 = 108{,}350$ lb. per sq.in. This quantity falls just short of the yield point of the material that was used.

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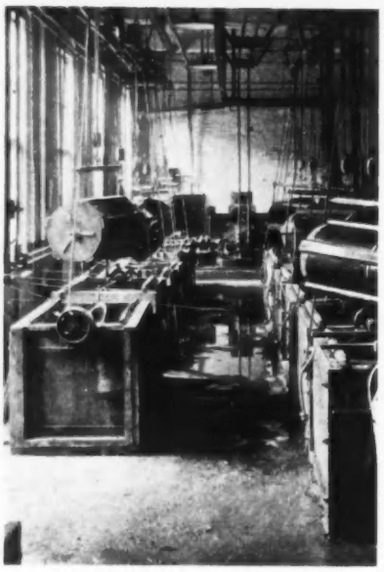

Design for Electroplating

By GUSTAF SODERBERG
Udylite Process Company

An expert in plating processes points out the factors which the designer should consider but which he frequently overlooks

DURING the last decade increasing attention has been paid to surface finishing, applied for the sake of appearance and for protection against corrosion. Electroplating has turned from a mysterious secret into a science, leaving the dirty, poorly ventilated room in the cellar to become an integral part of the manufacturing process. Electroplating brings live problems to the designer, because the success of the plating process both from a technical and an economical standpoint often depends upon the design of the part to be electroplated.

Before going into a detailed discussion of the problem it might be well to review the subject of plating as the plating foreman sees it. The "work" comes to the plater with grease and oil on its surface, sometimes rusty or covered with scale. This foreign matter has to be removed prior to plating, because the plate will adhere only to a chemically clean metallic surface. Aside from mechanical cleaning by means of abrasion in tumbling barrels or by sand blasting, the cleaning procedure generally involves two distinct steps, namely, first, cleaning in an alkaline solution to emulsify and remove oil and grease, and second, pickling in acid whereby oxides are dissolved.

The still-plating tank typifies the whole principle of plating. Across the top of the tank that holds the plating solution are three copper or brass rods. The two along the sides of the tank carry the anodes through which the current enters the solution from the generator. The central "work rod" carries the articles to be plated, which are suspended in the solution on wires, hooks or specially designed racks.

The alkaline cleaner tank is constructed and operated in a similar manner. Hydrogen gas is deposited on the work instead of metal, as is the case in the plating bath. The very vigorous hydrogen evolution loosens the grease and dirt on the surface of the work and suspends it in the solution by emulsification. The principles of design which hold for electroplating are equally valid for electrocleaning.

In order to provide a certain resistance to rust and corrosion the plate is specified to have a certain minimum thickness which varies according to the type of exposure to which the object is subjected and to the desired life of the coating. Any excess of metal deposited on any one point is a definite loss.

It may be stated that a uniform thickness of plate can only be approximated. The illustration in Fig. 2 tells why. The anode is shown at *A*, and the cross section of the object to be plated is at *B*. A fundamental law tells us that the current which transports the metal and deposits it on the object will take the shortest route. In other words, most of the current will go to *d*, and there give a thick deposit, while *b* gets only a thin coating, and the corner *c* only a flash. In order that *c* will get the minimum thickness specified, it may be necessary to put on a heavy coating at *d*. This takes time, requires more equipment and current, and more metal.

Fortunately, the metal distribution from most

plating baths is more even than such a calculation from dimensional data would indicate. Most solutions have what is called throwing power, because certain resistances to the current are set up at the points of highest current density and force the current to deposit more metal at points of lower current density. This throwing power varies from metal to metal, depending on one hand on the inherent character of the metal, and on the other hand on the type of solution that is used.

In general, alkaline and cyanide solutions are considerably better than acid solutions. Of the commercial solutions, the alkaline-tin and cyanide-cadmium baths have the highest throwing power. Next come cyanide copper and zinc. Nickel, acid copper and zinc follow. Finally, we have the chromium solution, which has a negative throwing power. The exact composition of the solutions is often very important. The design of the article frequently makes it necessary to use a solution with high throwing power, and is often the deciding factor in regard to the kind of electro-deposit that should be selected. This is one of the reasons why cadmium is preferred to zinc for rust proofing.

The plater can do several things to equalize the distribution of the coating. He will, if he knows his business, keep his plating solution at the maximum throwing power, which involves frequent chemical analyses of the bath. He can also spend more time on the cleaning operation, thus increasing the apparent throwing power. Finally, there are a number of methods that can be resorted to in order to obtain a more even current distribution, such as the use of "thiefs," "shields," or conforming anodes. These methods are used in chromium plating in particular, and introduce new cost items.

Correct design will do a great deal towards cutting costs. Unnecessary depth of hollows should be eliminated, and sharp corners can often be rounded off. In extreme cases it will even pay to divide an unnecessarily complicated part into two parts.

The distribution of the current is much affected by obstacles in its path. In Fig. 3 this point is demonstrated. It is a box with a small opening toward the anode. Even the best plating solutions cannot "throw" much metal at *e*. In the case when protection at this point is of vital interest, it is necessary to redesign the box and provide for a larger opening, if inside anodes are to be avoided.

Practically all metal deposition is accompanied by deposition of hydrogen gas, which forms gas pockets if not allowed to escape, thus preventing the plating solution from coming into contact with the surface to be plated (corner *e* in Fig. 2). In order to plate at such areas, the plater can sometimes re-rack the work when it is half plated in order to change the position of the gas pocket. The result is loss in time and unnecessarily heavy deposit on other areas.

The designer can frequently eliminate this condition by changing the inside curvature of the article. If such a course cannot be followed, he can place a small hole where the gas is likely to accumulate. An added punch on the die or a small change of the casting pattern is often all that is necessary, but even an added operation in the machine shop will often pay many fold in the plating room.

SIMILAR precautions are needed to prevent cleaning and plating solutions from being carried over into the water rinses (at *g* in Fig. 2). These solutions represent definite values, and the quantities lost through faulty design mean a surprisingly large addition to the cost. Furthermore, unduly contaminated rinse water causes trouble, and must be replaced by fresh water which also costs time and money. A slight change in design may result in a substantial and direct saving. It will also add to the life of the solutions and lessen the amount of chemical control necessary in the plating department.

One of the first questions a plating foreman asks himself on examining a new piece to be plated is, "How should it be racked?" The problem is not at all a simple one. The work rod must be connected to the work at least at one point, and if the article is large, at several. Generally,

IT IS unreasonable to expect all surfaces to be plated with equal coats, as is seen here

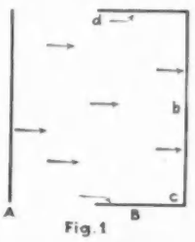

Fig. 1

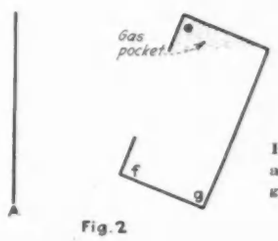

Fig. 2

PLATING costs can be cut if parts are designed with consideration of gas pockets and hidden surfaces

the work is hung on a hook or held by spring action. The article cannot be hung haphazardly. Recesses must face the anodes, and protruding points must be as far from anodes as possible. Gas pockets must be avoided. When the article is taken out of the solution, it must be drained off properly. Furthermore, the racking arrangement must not shield the work from the current.

All these factors must be seriously considered when provision is made for a place to put the hook. The center of gravity must fall considerably below the point of suspension. The work should slide easily down into the solution. It takes considerable weight or pressure to force a flat surface, or a cup-shaped article with "bottom" up or down, through the surface of the solution. If the work is of light material or thin stock, it unhooks easily and falls to the bottom of the tank. The attention to all these points adds to the cost of plating.

The question of suitable design is particularly important if the articles are to be plated in full-automatic plating machines. Such machines have cut plating costs tremendously when used in mass production. From our present point of view, however, they have distinct drawbacks. The work is racked by hand and the racks hung on a mechanical arrangement which carries the articles through the various solutions, lifting them in and out of the different tanks. While the total time in the machine is variable, the set-up is lacking in flexibility. The procedure cannot be changed easily from one job to another. The size of the racks is limited. The rate of upward and downward movement in transfer from tank to tank cannot be varied. Work cannot be re-racked conveniently during the cycle of operations. This exclusion of the human element frequently makes it impossible to plate parts in an automatic machine without change of design.

To summarize, some of the points to be watched in the design of articles to be plated, are:

1. Depth of hollows
2. Shape of inside corners
3. Shape of projecting parts
4. Shielding of one part by another
5. Elimination of gas pockets
6. Proper draining
7. Method of hanging on hooks or immersing
8. Stability of suspension

We hear so often about co-operation and co-ordination of effort. Many times they are empty words only. Real co-operation between the designer and the plating department can eliminate much trouble and produce a better quality at a lower cost.

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BOOKS FOR ENGINEERS

POLICY AND ETHICS IN BUSINESS. *By Carl F. Taeusch, associate professor of business ethics, Harvard University. 624 pages, 9¼x6½ in. Clothboard covers. Indexed. Published by the McGraw-Hill Book Company, Inc., 370 Seventh Ave., New York, N. Y. Price, $5.*

IN these days when the engineer is finding himself more and more an active part of the executive organization the reading of such books on general business as this one becomes for him almost a necessity. The subject discussed by Professor Taeusch is one to which anyone who has interest in the proper conduct of the business should give thought. It is not to be expected that everyone will agree with all conclusions drawn in this book, as the "ethics," or anything relating to the absolute right and wrong of business is always open to discussion. Professor Taeusch, himself, at times in the book seems to get confused as to cause and effect or rather as to what is the seed and what the soil.

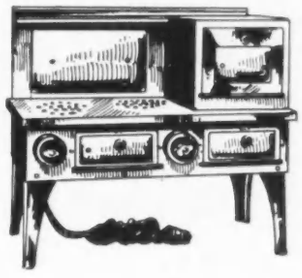
Because, as the author states, business facts are intimately woven into the social life of the people the first part of the book is devoted to a considerable discussion of the land, the nature of the people, and the religious and social ideas that have an effect on the business life of the community. All of this makes interesting reading. The major part of the book comprises specific cases.

MODERN DIESEL ENGINE PRACTICE. *By Orville Adams, Consulting Diesel Engineer. 650 pages, 6x9 in. Clothboard covers. Indexed. 390 illustrations. Published by the Norman W. Henley Publishing Company, 2 West 45th Street, New York, N. Y. Price $6.*

DAY by day, the importance of Diesel engines becomes more apparent, and, consequently, an ever-increasing amount of literature on the subjects of their design, operation, and maintenance becomes available. Most works stress one phase of the subject, approaching it from the standpoint of the observer rather than the user, many of them limiting themselves to a theoretical survey. This volume is an operating handbook, however, explaining the history of the Diesel, its development, technical application, operation, maintenance, engineering, lubrication, application to stationary and mobile service, and automotive applications, including the new Packard Diesel engine.

The book is replete with charts and tables giving performance data. Designers engaged in Diesel practice or expecting to enter this rapidly growing field will find a wealth of up-to-date material in the volume, material of a type which will assist them in understanding, applying, and developing further uses for this method of producing power. The author, as he discusses various types, explains the materials incorporated with the reasons for their incorporation, and design elements involved with their relations to one another.

Toys Must Mirror Full-size Designs



FAITHFUL miniatures of commercial products, designed to incorporate durability, value, safety, economy, and eye appeal, sold best at this year's Toy Fair in New York, held for department store buyers in this important $100,000,000 market. One make of toy electric stove incorporates actual oven heat indicators, switches of the mono-directional type applied to a full-sized stove, double-walled and warming-ovens, Nichrome heating elements in porcelain holders and with porcelain insulators and a finish of resin enamel capable of resisting the heat necessary to bake bread and make candy. The builder thus has sales data for parent as well as child—for the child appearance, utility, and faithful reproduction of the full-size model, and for the parent standard materials, parts, and finishes, safety, and value. The analogy might be carried through dozens of other lines of toys, steam engines, trains, structural sets, aluminum ware, wagons, autos, dial phones, and boats.

Pressed steel, castings, wood, lithographed sheet iron, enamels, varnishes, and lacquer are used in the majority of the toys. One use of molded plastics, a full line of toy structural blocks in a variety of colors, was shown. These have a more brilliant and uniform color than is possible with stone, and are more durable and easily formed than wood. Toys to be used in the house are lacquer sprayed or enamel dipped, while toys to be used outside are usually in baked enamels. For electric appliances, designers have had some difficulty in obtaining a low-priced finish that will stand up under heat.

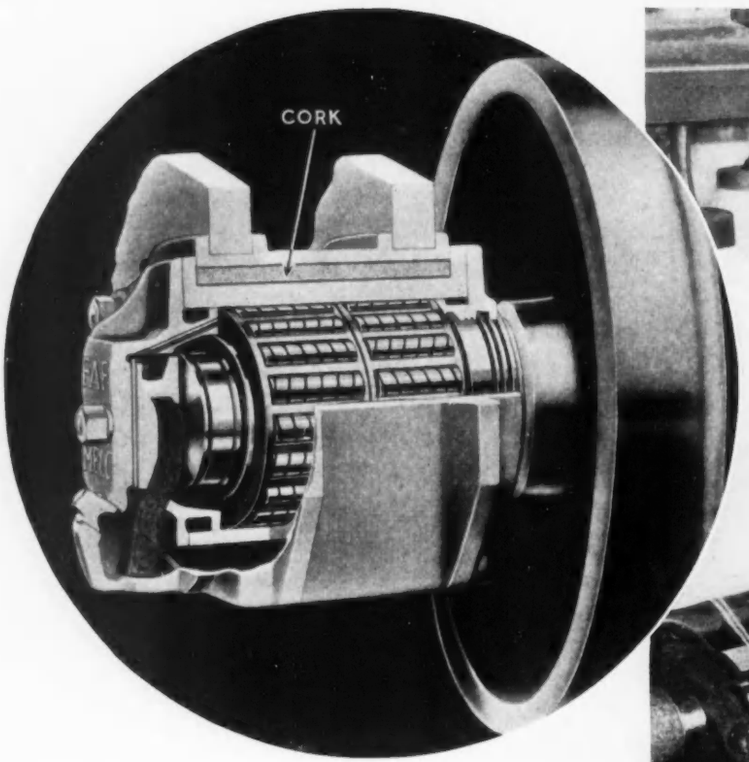
Chromium plating is finding increasing use in tricycles and bicycles and where open-air use is intended. For many interior toys, however, it is not used, since it represents an additional plating process, increased cost, and difficulties in controlling the process which designers prefer to avoid. Aluminum has become popular for toy dishes and cooking utensils because it is easily drawn and requires no finishing. Even the polishing operation can be eliminated in many cases. One company making such a line duplicates every full-size utensil available, including casseroles, percolators, samovars, dishes, cutlery—every piece a working miniature. One percolator, less than 3 in. in height, reproduces the glass top and wooden handle. As an example of attention to detail, the samovars are equipped with nickel-plated brass spigots to avoid contaminating the milk. Illustrative of the care going into the design of this class of toys is one case where as many as 30 models were made before the desired graceful lines of the full-size pitcher were duplicated. This same maker provides non-rusting aluminum sand pails and beach toys capable of resisting salt water at a price comparable with tinned or galvanized ware. Designs in color are sprayed on with lacquer.

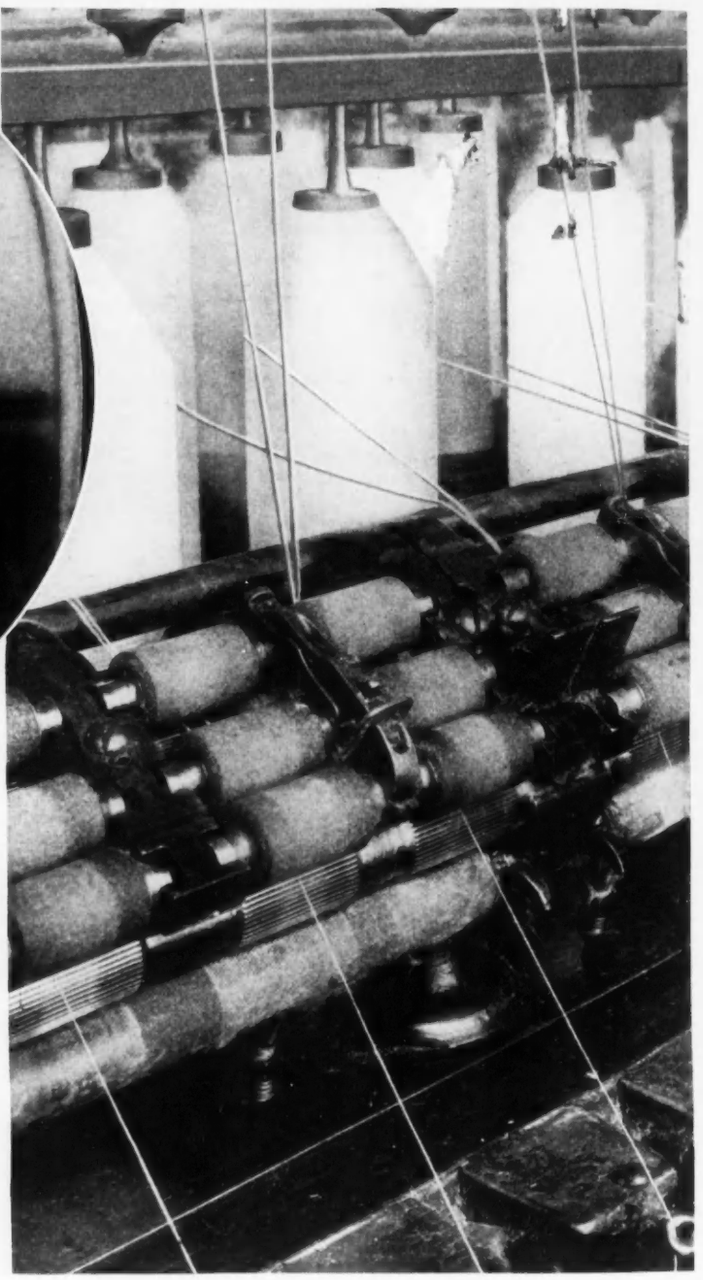
Designers are making a particular effort to satisfy the mechanically inclined boy. A replica, 5 in. high, of the Johnson "Sea-Horse" outboard motor is of pressed steel, enameled on parts above water and with a nickeled pressed-brass propeller and shaft. Power is supplied by a spring motor. One toy shipbuilding outfit incorporates a hull and enough parts to make more than 30 different types of boats. The hull is of pressed steel, 23 in. long, and is built to operate in water. Funnels, decks, and other parts are provided to make the various operating models. The same designers incorporate in larger structural sets a two-drum miniature electric hoisting engine equipped with a 110-volt Polar Cub universal motor and a multiple-disk clutch capable of operating with any of 400 models.

Another new toy that shows the mechanical design trends is a steam locomotive, 12 in. long and alcohol operated, which is capable of pulling four or five cars on a narrow-gage track and running for 35 to 40 minutes on one firing. The burner is of especial interest. The alcohol receptacle is mounted under the cab, and can be filled in place if desired. From it, a small pipe extends the length of the boiler, having six outlets or burners. When originally constructed, it was found that the several wicks nearest the alcohol supply drew all the alcohol, causing the farthest burners to go out. This has been corrected by putting a small well below each burner wick, the supply line filling the wells and the wicks drawing from them. The danger of fire, if the locomotive is overturned, is guarded against by a specially designed C-shaped flame guard over the burners, out of which the flame cannot come. The boiler is of pressed brass, and is filled with water through a "sand dome" at the top. Steam drives the miniature cylinders at either side, then exhausts through the smokestack, just as "smoke" should. The locomotive is made safer by being geared so that it will not jump the track. Finish is black and red enamel and polished brass.

The same designers have produced an electrically heated reversible double-acting stationary engine with fittings in nickel plate. The base is of pressed steel in bright red baked enamel. A lever on the steam chest permits the cylinder to be thrown in neutral, forward, or reverse. Safety valve, water glass, and of course a whistle, are incorporated.

One cost-saving trick that promises to be of increasing value in the design of toys retailing for 25 cents or less is the use of lacquered sheet iron, lacquered by a continuous process with different colors on opposite sides before forming into the Zeppelins, trains, and similar toys.



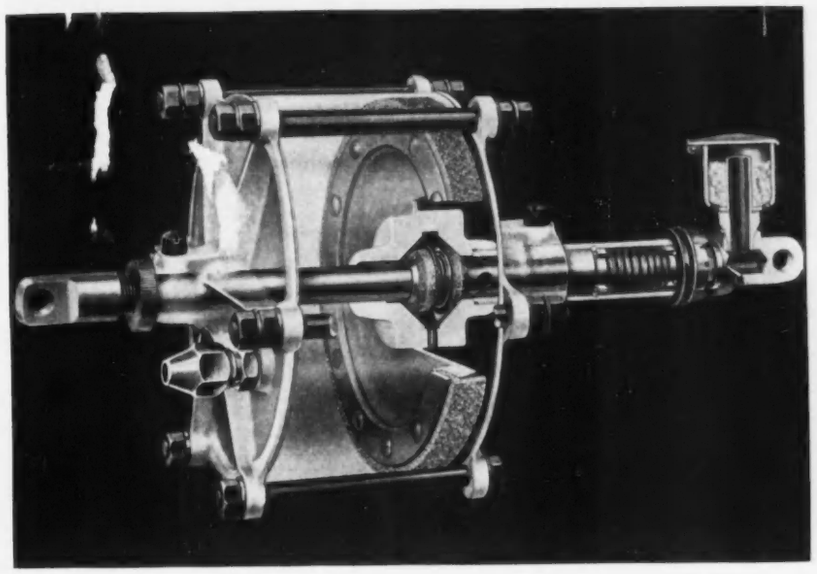


Sealing, Gripping, Shock-absorbing with Cork

A LONG record of industrial usefulness antedating that of most materials is credited to cork, which owes its wide range of service to the cellular structure that makes it a natural insulator. Packed closely together and so irregular in shape that each cell provides fourteen points of contact with contiguous cells, the microscopic particles of dead air inclosed within thin elastic walls and held together by a natural bond, give cork a combination of qualities suitable for many mechanical and industrial uses.

Because the structure is cellular rather than fibrous, there is little capillary attraction in the presence of oils and other liquids, and because there is more than 50 per cent entrapped air by volume, the material is characterized by a high degree of resiliency and compressibility and has a very slow rate of fatigue under a continuous cyclical pressure. Unlike most other compressible and resilient materials, cork does not flow to any great degree under pressure, but yields largely by the compression of the air in its cells. Low thermal conductivity and buoyancy are also attributes of this peculiar structure, and the high coefficient of friction, which is giving the material a wide range of application, may be at least partly explained by this cellularity.

Regardless of how outstanding any one specific property of a material may be, the industrial adaptability of every material depends on the combination of its physical properties. Furthermore, the field of usefulness for all raw materials is sharply restricted by the natural variations in the material itself. Cork is no exception to the general rule, and while it has a wide range of usefulness in such articles as bottle stoppers, floats, life preservers, and other things made of natural cork.



PISTON RING and two valve seats of cork are used in this B-K Brake Booster for trucks. When the foot brake is applied, the suction in the intake manifold of the motor exhausts the air at the left of the cylinder, and air at atmospheric pressure acts against the other side of the piston

IN this cotton spinning frame the cork-covered rolls are held against positively-driven fluted-steel rolls which drive them by friction

CORK composition blocks, ¾-in. in thickness, are used with this roller bearing journal for railway cars. They deaden noise and vibration and support the weight of the car without taking an appreciable "set"

By F. L. MUNROE

Armstrong Cork Company

it was not until compositions were developed that a group of cork materials designed to meet a broad range of mechanical requirements was placed in the hands of engineers and designers.

Because of resistance to liquid penetration, permanent resiliency and non-flowing properties, cork makes an effective seal and is now widely used as a gasket material, particularly in conjunction with stampings. Oils and greases have little deteriorating effect on cork, and hence composition gaskets have, within their range of temperature and pressure, established themselves in many fields. Cork compositions are particularly adapted to the problems presented by the assembling of glass and porcelain to metal, where their compressibility and permanent resiliency speed up assembly, reduce breakage in assembly and in service, and make effective seals even under comparatively light compression. Cork compositions are thus specified in assembling automobile body glass to channels, in automobile headlights, and in the assembly of porcelain parts in transformers and other electrical equipment.

Cork is also used as a seal for antifriction bearings. While it is necessary to fabricate the cork parts to closer working tolerances than is usual for other types of seals, its resiliency combined with low capillarity, makes it effective for sealing lubricants in and excluding foreign matter from bearings. Its limitation in this service is the comparatively low tensile strength, prohibiting use in certain types of bearing design. Moreover, its use is not indicated under conditions of excessive pressure nor where temperatures greatly exceed 200 deg. F.

The frictional coefficient of cork is higher than that of leather, rubber, and some other materials commonly used for frictional services. In the presence of oil the material retains its frictional efficiency to a remarkable degree. Cork compositions are used for friction rolls in textile mills for drawing and spinning yarns; in wrapping machinery for feeding paper, foil, and Cellophane; in some forms of friction drives; and in certain types of clutches. It is also used as a brake lining in some mechanical devices where the action must be positive and immediate. Cork is not indicated for use where any considerable degree of intentional slippage is called for because the frictional heat generated under such conditions soon renders it ineffective or breaks it down completely.

Cork has been used for many years for cold storage insulation where constant temperatures must be maintained. Thermal conductivity of pure corkboard ranges from 0.25 B.t.u. per sq.ft. per in. thickness per deg. F. temperature difference per hr. for corkboard weighing 5.4 lb. per cu.ft. to 0.30 B.t.u. for 10.6 lb. material (U. S. Bureau of Standards). Corkboard is used to insulate refrigerators, ice cream cabinets, refrigerated display cases, and in the form of pipe covering is used for insulating cold lines conveying brine or ammonia.

Another major use of cork mechanically is for deadening the vibration of presses, motors, fans, and other machinery, rotary or reciprocating. Blocks or strips of the material placed under operating machinery absorb vibration and prevent its transmission to the building structure. It is also used for lighter vibration deadening purposes in meters, gages, and other recording devices and instruments.

Generally speaking, cork is chemically inert and can be used in contact with most chemicals except alkalis, strong acid solutions, and certain organic solvents. No destructive action, chemical discoloration, or corrosion takes place in the presence of oil, grease, or gasoline. It is not subject to progressive deterioration, and great pressure for protracted periods does not alter its structure or properties. Parts made of cork, therefore, will ordinarily last the full life of the mechanism.

As is the case with all raw materials, various obstacles have been met and surmounted in adapting cork to mechanical services. The greatest of these, the characteristic variation of natural cork, was overcome by granulating the bark and reuniting the particles with binders under pressure to form compositions. Considerable tensile strength, a quality which natural cork lacks, has been added by reinforcing cork compositions with sheets or layers of cloth or fiber. Another development has been the production of compositions in which rubber or synthetic resins are used as binders. Such compositions possess properties not present in the component materials alone and offer new materials with which engineers and designers can meet new mechanical requirements.

COMMENT AND SUGGESTION

THE COMMENT AND SUGGESTION SECTION is a forum for exchange of opinion. Readers are invited to write letters discussing matters of current interest to development engineers. Articles of a controversial nature, however, will be published only with a bona fide signature.

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Finish Standards

By Ralph M. Gamble
Designing Engineer,
Jones & Lamson Machine Company

IN THE March number of *Product Engineering* I was interested in the item headed "Finish Standards." It has been my experience in the dozen or more years in drafting rooms to go by the somewhat tradional methods of the particular company with which I may be at the time. When a suggestion is advanced as to how this or that thing may have been done, by a method employed by a company for which I had worked, the answer is invariably, "Oh well, we have always done that this way here." Occasionally, suggestions regarding design will be adopted, but not so those relating to such standard practices as finish marks.

The best system I ever used, in my judgment, was in a well regulated but not too systematized drafting room with a personnel of no less than 150 engineers, designers, detailers, and tracers. The finishes were graded into five classes as follows:

F1—Polishing finish. Obtained by carefully grinding, lapping, or scraping, and used on shaft journals and sliding surfaces where the best possible surface is wanted.

F2—Ordinary grinding finish. Obtained by grinding only, and called for on surfaces that slide at relatively slow speed, for shafts between bearings and other machine parts which must be kept clean and free from dirt and oil.

F3—Smooth machine finish. Obtained by milling cutters, finishing lathe, planer, or shaper tools, and used for surfaces that do not slide, except as the case warrants, where adjustment is required, and also on surfaces bolted together, and on cams, gears, pulleys, levers, and other parts requiring a true surface for squaring up, and locating or attaching other parts.

F4—Rough machine finish. Obtained by ordinary roughing tools, and used for surfaces needed only for lining up and locating, and which were painted after the machine was completed.

F5—Smooth forge finish. As the title implies, no machining was needed.

Much time was saved by using such notes as, "F1 All Over," "F3 Unless Otherwise Specified." These notes were placed in the heading of the detail along with other specifications such as browning, bluing, tinning, plating, etc., and helped to simplify the job for the checker and all concerned.

I have seen plenty of time wasted in shops where such a system is not in use in the preparation of engineering drawing. Without such standards the workmen do not know just how "fussy" they should be with surfaces, nor what surfaces are important.

■

STOP... LOOK... LISTEN...

•

DESIGN FOR SAFETY

AT the insurance conference of the American Management Association on April 29 it was brought out that recent court decisions have held the manufacturer of an article liable for injuries sustained by the consumer in the use of the article. Such a doctrine if carried to extremes might soon make some ridiculous situations. It might be interpreted, for example, that a machine manufacturer is liable for injuries sustained in the operating plant where the machine is installed. But, nevertheless, it ought to cause designers to give some extra thought to safety in the product being planned.

•

SOUND-PROOF BODIES

SOUND-PROOF bodies have long been the goal of bus designers. One inventor proposes to form the body from metal lath, spray fiber on the skeleton, press it into place, and vulcanize it. Lightness, flexibility, and sound absorbtion are claimed.

•

PLATE THE SLIDING JOINT

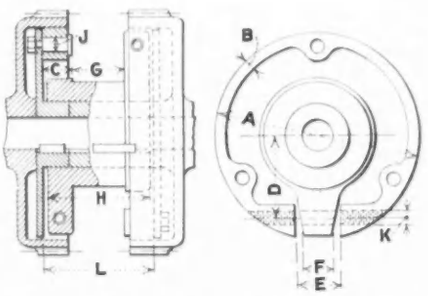
CHROMIUM plates in fairly heavy thicknesses have been found to serve well on wristpins, steering knuckles, and other parts where wear resistance is an important factor. This idea does not seem to have been carried into applications to moving parts of industrial machinery. A heavy chromium plate will have a hardness above that of casehardened steel and a very low coefficient of friction. Machine designers ought to keep it in mind when thinking of contacting parts where lubrication is difficult.

■

Proportions for Toggle Friction Clutches

By A. Mitchell
Halifax, England

THE accompanying table on "Proportions for Toggle Friction Clutches" I have found a time saver in the drafting room. I am certain that it will be of considerable assistance to other designers engaged in similar work.



A	B	C	D	E	F	G	H	J	K	L	Movement
7"	9/16"	1 5/16"	2 3/4"	1 1/2"	1 1/4"	2"	4 9/16"	1/2"	5/8"	5"	7/32"
8 1/4"	13/16"	1 1/2"	3 3/8"	1 5/8"	1 3/8"	2"	4 3/4"	1/2"	5/8"	5 1/8"	3/16"
9 1/2"	7/8"	1 3/8"	3 3/8"	1 7/8"	1 5/8"	2 1/4"	5 1/4"	9/16"	3/4"	5 3/4"	1/4"
11"	7/8"	1 7/16"	4 3/8"	2 3/8"	1 3/4"	2 3/8"	5 1/2"	5/8"	3/4"	6 1/8"	5/16"
13"	7/8"	1 1/2"	5 1/4"	2 3/8"	1 7/8"	3 1/8"	6 3/8"	11/16"	3/4"	7"	5/16"
15"	1"	1 1/2"	6 5/16"	2 3/8"	1 7/8"	3 1/8"	6 1/2"	11/16"	3/4"	7 1/4"	3/4"
17"	1 1/4"	1 5/8"	7 1/4"	2 3/8"	1 7/8"	3 1/4"	6 3/4"	11/16"	15/16"	7 7/16"	11/32"

Small-Quantity Reproductions

By H. H. Sullivan
President, Paragon-Revolute Corporation

I AM rather surprised at the remarks of J. R. Hillyer, in the November number of *Product Engineering*, regarding the ease of using a Ditto as compared with a blueprint. A pencil tracing is more easily made than a Ditto stencil, and also forms a permanent, easily filed, record. Many simple copying processes, other than blueprinting, will give copies which do not require washing in water. For those who do not have printing equipment, any local blueprinter will provide four or five copies cheaply, returning original and prints in short order. In my opinion this is more convenient. I am acquainted with both processes, and give me a blueprint every time, both for ease of production and for legibility.

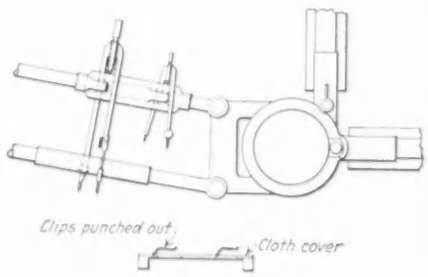
■

Instrument Holders for the Drafting Machine

By David C. Bailey
Engineer, Bailey Manufacturing Company

THE article on "Thumb Tack Pad on Drafting Machine" in the March number of *Product Engineering* prompts me to offer the following:

The efficiency of the drafting machine may be increased by adapting



it to hold the more frequently used drafting instruments such as the compasses and dividers. This may be done by clamping spring-metal clips on the parallel bar adjacent to the handle. Strips of soft cloth are cemented to the bars to serve as cushions so that the instruments will not be thrown out of adjustment.

The habit of returning an instrument to its clip is quickly formed. Then, no matter on what part of the board the drafting is being done, the instrument will be in the same relative position to the hand. Each instrument may be picked up and returned without taking the eyes from the paper. Moreover, since the drafting machine requires a clean sweep over the table, it is not necessary to watch out for the instruments each time the machine is moved.

■

KEEPING 'EM TIGHT . . .

AIRPLANE engine builders use an aluminum-bronze valve seat in an aluminum head because the expansion coefficients of the two metals are nearly alike. But with the cast-iron cylinder block used in motor bus service it is a different matter, and bronze seats do not stay put because of expansion even when shrunk in. One motor bus engine builder is using a cast-iron valve seat with a Stellited face, and screwing it into the block. When we learn that some of these buses pile up mileage at the rate of 20,000 miles a month there may be a reason!

•

VERSATILITY . . .

AN engineer writes us that he wants to use a drive shown for a machine as an adjunct to a grain elevator. Another wants to apply a vertical motor, illustrated on a drill shown in *Product Engineering*, to a totally different kind of product. These indicate real product engineering. We can all learn from the other fellow, no matter how different his product!

•

STRAIGHTJACKETS FOR CRANKSHAFTS

MANY designers advocate a bearing between every crank throw of a shaft. One engineer says this is an acknowledgement of a weak or unbalanced shaft. "Putting a straightjacket on a crazy man doesn't cure him," he says; "Make the shaft heavy enough and balance it, and you need only a few bearings. There is still a good 4-cylinder truck engine built with merely a ball bearing at each end of the shaft."

•

. . . CENTURY PLANTS . . .

IN 1855, Robert Wilhelm von Bunsen designed and procured a patent on the first successful method of burning gaseous fuels. The Bunsen principle is still being used, despite the objections of low efficiency and oxidizing flame, but now comes a burner, invented by Lee Mettler, which is claimed to eliminate these disadvantages. It is constructed on the multi-unit, multi-jet principle, each burner consisting of a number of mixing tubes, each of which is supplied with gas through several jets meeting in a predetermined central point in the mixing tube. The result is much improved combustion. The burner is now on exhibit in mechanical museums, hailed as "the first substantial improvement in the Bunsen burner in 69 years." One way to attain lasting renown seems to be to leave the beaten path!

•

. . . WEIGHT REDUCTIONS . . .

IT is stated that in the construction of the German passenger ship "Bremen," about 800 tons weight was saved by using steel of 30 per cent greater strength than mild steel. This indicates a high grade of engineering skill. It requires ability and self confidence to reduce dimensions to take advantage of a stronger material. For a number of years designers of locomotives kept using the dimensions of carbon steel connecting rods even for rods made of high-strength steels.

Capacitor Motors

By R. E. Smith
Small Motors Engineering Department, Westinghouse Electric & Manufacturing Company

REFERRING to the article on electric motors that appeared in the March number of *Product Engineering*, there are a few points that ought to be clarified or amplified.

In capacitor motors for low starting torque, up to 75 per cent of full load torque, such as for fan duty, where a transfer switch cannot be used, one of the windings is connected directly to the line and the other is connected to the line in series with a capacitor. The same value of capacitance is used for running and starting. In some cases, such as for regulator and hoist service where the starting torque must be high and the motor is to be used for reversing service and intermittent duty, a large value of capacitance is used to obtain the maximum starting torque possible. In this design, the phases are badly unbalanced at full load speed and the motor cannot be used for continuous duty.

For high starting torque in motors required to operate continuously, an auto transformer is used in connection with the capacitor. Taps are brought off from the transformer so that a step-up ratio is obtained on the capacitor, which is connected across the ends of the transformer. In this way, the voltage is increased on the capacitor, the effective capacitance of the unit increasing as the square of the voltage ratios. The auto transformer is connected in series with the capacitor phase winding of the motor through two of the taps. Different values of capacitance are used for starting and for running by transferring the connection from one tap to another on the auto transformer. The change is made by the use of either a centrifugal transfer switch or a magnetic transfer switch.

Another type of high starting torque motor is a capacitor start motor in which the capacitor, or auto transformer and capacitor, and the starting winding in the motor are connected in series to the line for starting only, and are disconnected when the motor comes up to speed.

PRODUCT ENGINEERING

Editor: KENNETH H. CONDIT

June, 1931

***. . . A market is never saturated with a good product, but it is very quickly saturated with a bad one, and no matter how good anything is when it is first produced, it will not remain good unless its standard is constantly improved.*—Henry Ford.**

Guideposts and Weathervanes

SAYS President Schneider of the University of Cincinnati, "In twenty-five years many of our guideposts have become weathervanes." A most apt statement when you study its significance.

Before 1900 we had some pretty definite economic guideposts, developed through years of slow economic progress from an entirely agrarian toward a partially industrial system of political economy. Then the modern machine age dawned, and our solid guideposts began to flutter like weathervanes. Output per worker increased enormously, and real wages followed the same upward trend. We finally awoke to the fallacy of holding down wages and accepted the relation between the high wage and adequate purchasing power.

Until about the same period cast iron was cast iron, and steel was steel. We knew pretty well what could be done with them, and with other common materials of industry. And then scientific research turned its attention to industrial problems and we soon had more than fifty-seven varieties of alloy steels, and other materials in proportion. Once again the old guideposts swung widely.

Economically we are faced with wide sweeps of the business curve from hectic prosperity to black depression. The old guideposts are indeed weathervanes.

Industrially we must reckon with a new force, scientific research. It obsoletes our pet processes overnight, and develops new products, and new principles that lead to new products, almost daily.

President Schneider insists that the most important factor affecting future business is research. If he is as correct in this conviction as he has been in others, industry must keep an eye constantly on the weathervane of scientific discovery so that it may always be alert to adapt new principles to its own ends.

■

Drafting or Designing?

AT THE annual meeting of the Society for the Promotion of Engineering Education to be held June 17-20 at Purdue University, the principal topic for discussion by the Machine Design Division will concern the question of how much time in machine design courses should be devoted to teaching drafting room methods and how much to teaching theory.

A recent survey conducted by Professor Eidmann of Columbia University revealed that some of the teachers pare their drawing room courses to a minimum while others emphasize this phase of the subject of machine design almost to the exclusion of classroom work in theory. There is evidently nothing like a consensus of opinion as to the proper method of teaching the subject.

Universities should not undertake to teach those subjects which can be taught better by industry. There is no substitute in school for the practical experience that can be gained when serving a period of time at the drafting board of an engineering department. On the other hand, applied mechanics, strength of materials, mechanism, and design calculations cannot very well be taught in industry. It is significant that some employers of engineers have complained that it is difficult to find graduates of American universities who are capable of making original design calculations that will be dependable.

Let the engineering schools devote their time to teaching the fundamentals of machine design, including in their courses only such an amount of drawing room work as may be necessary for teaching projection and layout. The job of devel-

oping skilled draftsmen capable of turning out professional looking drawings should be left to industry. A technical graduate capable of making original design calculations and investigations is of greater value to industry and himself than one who has been trained in the art of skillful pictorial presentation at the expense of a fundamental conception of the subject of design.

■

A Little Child Shall Lead Them

UNPREJUDICED minds with fresh viewpoints often upset the traditional thinking of a man or an industry whose nose has been kept too close to the grindstone. The naïve, simple question may open up a whole new avenue of ideas.

One of the largest mail order houses has as a part of its research department, which is under the leadership of a retired army general, a merchandise analysis section headed by a psychologist whose assistants are young college graduates. Neither he nor his fellow workers have a technical background, but their influence has been felt in the development and improvement of a diverse range of products from window shades to washing machines. Suggestions for improvement in design and reduction of cost of manufacture often come, not from the supplying manufacturers, but from this research group.

Good electrically driven washing machines, for example, had been brought down below $100. The question asked was why couldn't the gasoline-engine driven unit for rural districts be sold in the same price class? The most expensive single item was the motor, supplied by a manufacturer who had specialized in these types for years. His answer to the suggestion of a reduction in price was that he had aready cut his costs to the limit. He had nothing to offer in a new design. The psychologist sought a new avenue of supply, reasoning quite logically that something similar to the high-speed, light-weight outboard marine motor would do the trick. It did. And the new motor costs but forty per cent of what the old one cost. Similarly, this research department found new products as outlets for expanded metal. It effected the development of a better flashlight for less money.

These, and many other changes, could have been suggested by the manufacturer's own engineers, but they weren't. It took the broader vision of men totally outside the industry, and freed from traditional ideas on the subject, to bomb them out of their complacent security. Perhaps the designer's wife and "severest critic" could better have passed on his pet design. Or perhaps that inquisitive young son who is always stumping his dad with simple questions might lift him out of the rut.

▼

New Designs for Old

ADVANCED designs often fail to get anywhere because they are merely dreams that do not meet any demand of the immediate future. Leonardo da Vinci's engines, automobiles and airplanes would not have gotten very far even if there had been tools and mechanics to build them. Shanks mare and a row boat met most of the transportation needs of his day.

But when the dreamer is only one jump ahead of demand, and both engineering and production are set to go as soon as they understand just what is needed, things are sure to pop with a little pushing. And that's just the case now with television. In the language of the poets, there's a hen on, and those who help along the hatching will be sitting pretty when the egg laying contest gets under way.

Television is here. Crude, perhaps, as were the radio sets of ten years ago. But there are six stations on the air at this writing, and kits are being made and sold so that the engineer outside the industry can expermient. Of course, the big research laboratories are improving apparatus every day.

The electrical end of the television problem seems to be pretty well licked, but there is a rare chance for improvement on mechanical design for manufacture. Pictures are already floating through the air ready to be picked up. What could offer better opportunities for the development of a product that means immediate new business?

▼ ▼ ▼

WHAT'S GOING ON—

Trends In Product Design

WITH the primary object of developing a coal car to produce more revenue per pound of weight on the rails, the Pullman company has completed five all-welded 70-ton hopper cars. They weigh 45,900 lb. each, or roughly the same as 50-ton cars of riveted construction. Conventional three-hopper construction was used with standard 4-wheel trucks, but the body design is a distinct innovation. The center sill is of welded tubular steel. Approximately 1,500 ft. of lineal welding were incorporated per car. The car is designed to take advantage of the welding to tie in all members so that all parts of the underframe and superstructure act as a unit in resisting draft, buffing, and load stresses. Pressed shapes, with large corner radii, are used for lightness and convenience. These provide stronger construction than riveted structural shapes. Sides are made of two sheets, butt-welded their entire length, fastened on the outer face of the side stakes in order to obtain maximum capacity for a given over-all width.

TWO MORE mercury-vapor units for the generation of power are to be put into commercial operation, one at Kearny, N. J., and the other at Hartford, Conn., in the near future. Each unit will have 20,000-kw. capacity, double the capacity of the first unit, installed in 1922 at the Dutch Point plant of the Hartford Electric Light Company. Should similar units come into general commercial use they will have a marked effect on the design of power house auxiliary equipment, as well as on boilers and prime movers. A feature of the development was the necessity for providing means to detect even the slightest leakage of mercury. A detector using selenium sulphide was produced by the Research Department of the General Electric Company, consisting of a paper ribbon coated with the selenium sulphide and wound on a spool from which it is drawn over an aperture. Through this aperture the sample of flue gas or air is projected by a small fan. If mercury vapor is present, the yellow selenium sulphide turns dark. From a color chart, the concentration of mercury vapor can be determined.

GLOBE conveyor-feed drilling and tapping machine, which utilizes two separate spindle slides to permit time and speed differences in drilling and tapping. The straight-motion feed will handle work up to 6 in. wide by 14 in.

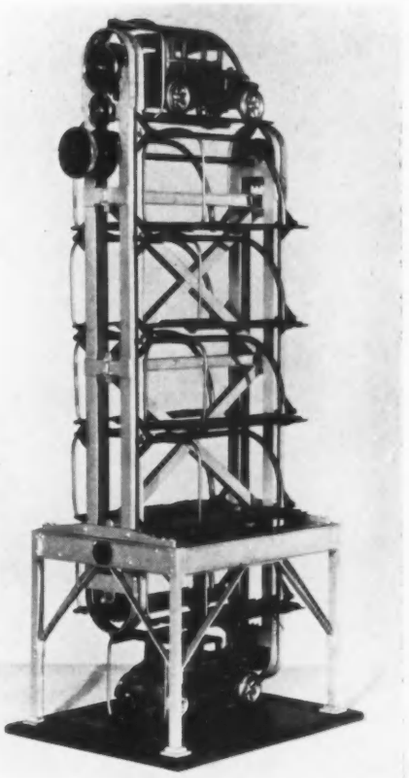
A Glance Over the Pages—

1. *What are the important elements of a waterwheel generator? p. 241*
2. *What is the average period of write-off of development costs of electrical apparatus? p. 247*
3. *How many variables are involved in determining the stress concentration factor for fillets at changing sections? p. 259*
4. *Is uniform thickness of electroplating possible without advance attention by designers? p. 262*
5. *What is the thermal conductivity of corkboard? p. 267*
6. *Why should chain wheels have as many teeth as possible? p. 253*
7. *How is rubber being used in chemical equipment? p. 250*
8. *Who has been nominated for the presidency of the A.S.M.E.? p. 276*
9. *Why is toy design important to the product engineer?. p. 265*

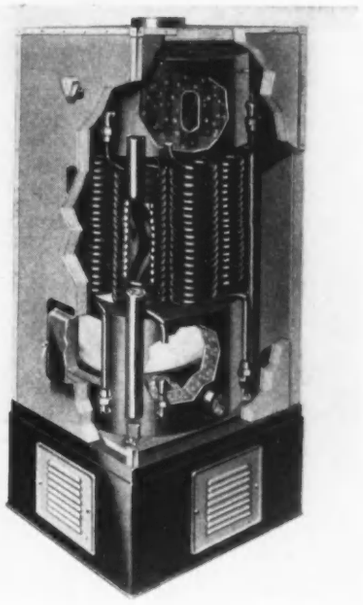
TO DECREASE the time required to soak bundles of silk, the Franklin Process Company has developed a machine that employs a continuous, reversible, forced-feed circulation at a hydraulic pressure ranging from 10 to 15 lb. per sq.in. The machine combines four units, the kier or tub in which the silk is placed, an expansion tank through which the soaking solution is added, a motor-driven centrifugal pump, which forces the solution through the silk, and a chain hoist for handling the cover. Auxiliary equipment consists of piping, valves, gages, and thermometer. All parts of the machine which come in contact with the silk or soaking solution are made of an aluminum alloy resistant to chemical action. The exposed surface are carefully finished.

A LOCOMOTIVE DUMP CAR has been perfected by the Differential Steel Car Company. Essentially it consists of a locomotive chassis with a dump body mounted upon it, power being supplied by a gas-electric unit. The equipment weighs 45 tons light and 80 tons loaded, and tractive effort of the locomotive varying with the dump body load. The power plant is mounted between the center sills for protection from dumped material. Engine radiators are of the sectional type mounted along the side sills and blown by centrifugal fans through holes in the side sills. Westinghouse combination straight air braking is used, actuated by a Gardner-Denver 60-ft. compressor belted from each engine.

WEAR TESTS on finishes, performed by the Bell Laboratories, were sufficiently extensive to require special equipment for the work. The units developed subject finishes placed on disks to the abrasive action of sand, thus simulating the mechanical rubbing which affects most telephone apparatus. The basic feature of the testing equipment is rotation of the disks in sand by means of a vertical motor and shaft. The chamber surrounding the upper end of the shaft and sample is filled with sand to a given depth, a compressed air injector arrangement circulating the sand while test is under way by taking it from the bottom and putting it in again at the top. A suction connection at the top of the sand chamber removes light waste material. This circulation also serves to cool the disk. Finishing materials must be applied very carefully in order to obtain comparative thicknesses. A spray gun is ordinarily used. In testing, metal disks are rotated at 1,000 rpm., wooden disks at 750 rpm. Wear indexes are established on a basis of the revolutions and wearing in toward the disk center.



MODEL of the Westinghouse automatic vertical parking machine, by which a car may be taken and returned by insertion of a key or a coin. Cradles, one per car, supported between two endless chains passing over sprockets, do the carrying



LOWER over-all price, better appearance, and higher efficiency resulted when boiler and oil burner were designed as a unit to form the Petro boiler. The burner is an adaptation of the rotary type. This points to the final stage in the development of oil-burning heating equipment

WELDED-DRUM boilers for a new U.S. cruiser, based upon the proposed A.S.M.E. specifications for fusion welding of power boiler drums, evoked considerable discussion at the recent annual meeting of the American Welding Society. X-ray tests of welded sections will be used. Another paper stated that the Detroit Edison Company will use welded piping for high-temperature steam. It is planned to use all-welded steel piping for the company's new 850-deg. plant, and welded stainless steel piping for a 1,000-deg. unit. Welding was adopted after it was discovered that ordinary flanged connections would not be satisfactory.

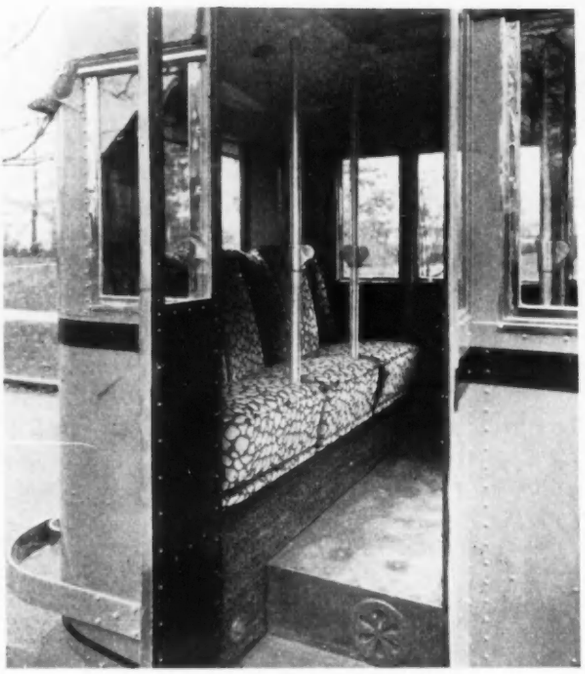
A SMALL, standard voltage Mazda lamp of low wattage to be used in the many new types of lighting ornaments and in signalling devices where heretofore carbon lamps were the only types available, has been developed by the General Electric Company. It is a 5-watt unit operating on 110 to 120 volts, with a candelabra screw base and a rated life of 1,500 hours, initially giving approximately 35 lumens.

INGOT IRON cribbing for retaining walls, developed by the American Rolling Mill Company, is built up from standard formed galvanized sections, either six or eight feet in length, held together by an interlocking device. Units are but one-fourth the weight of other known designs. Being non-porous, they do not assimilate water and do not spall.

ALUMINUM and aluminum alloys were used in the construction of a 10-wheel switching locomotive recently delivered to the Alton & Southern railroad, a subsidiary of the Aluminum Company of America. Boiler and cylinder jackets are of aluminum sheet. Main and side rods, crosshead links, combination levers, valve rods, and eccentric rods and cranks are of aluminum alloy. Running and cab boards and bumper and other steps on engine and tender are of cast aluminum. Many other detail parts, such as handrails and grab irons, are also of aluminum, as are parts of the tender booster. A 10 per cent saving in weight is estimated, in addition to which the lowered weights of the reciprocating parts reduced the counterbalancing required.

SHIPPING container using "dry ice" or solidified carbon dioxide. After delivery to the store, a glass cover may be put on in place of the opaque cover, the box then serving as a display case. The container is of wood, metal bound, with corrugated paper board insulation

MECHANICAL GRASS CUTTERS, under the tradename "Moto Mower," have a number of unusual design elements. The conventional T-shaped handle has two rubber grips, each of which operates the clutch on one of the driving wheels. Thus any desired direction of travel may be obtained. Speed is controlled from a throttle also on the handle. Cutting reels may be dropped out without disassembling the power unit. Five tempered crucible steel blades are provided and a positive throw-out clutch for releasing driving power is incorporated. Most parts are of malleable iron. Cutter bearings are self-adjusting Timkens, and clutches are three-plate dry-disk units. Driving chains are Diamond roller and lubrication is by Zerk fittings. Finish is gray enamel and cutting speed is 1½-6 m.p.h.



A KNOWLEDGE of textiles and decoration, as well as engineering, is required of modern designers. Here is the rear compartment of the "Taxi-Coach," showing individual upholstered seats. The fare slots in the stanchions relieve the operator of the task of collecting fares

HIGH-PRESSURE TURBINES are used in the Canadian Pacific "Empress of Canada" which recently set a new world's record for fuel economy, maintaining top speed at 0.57 lb. of fuel oil per S.H.P. per hour. The boiler consists of two large-diameter drums, placed vertically one above the other and connected by curved tubes arranged longitudinally and across the ends in such a manner that combustion space is practically entirely enclosed by water tubes. An additional line of water tubes divides the combustion space into two compartments. This provides a much larger tube area than conventional boilers. The four screws are independently driven by sets of Parsons single-reduction geared turbines, comprising one high-pressure, one intermediate, and one low-pressure unit, each driving a separate pinion which engages the main gear wheel. High-pressure units are designed for a maximum working pressure of 425 lb. per sq.in. and an initial steam temperature of 725 deg. F. Cast steel is used for the casings.

REFRIGERATION and quick freezing has made tremendous strides during the past two years throughout the food industry. The result has been an ever-increasing demand for new products required to keep pace with the advances made in this method of distributing food. Some outstanding developments in product design in this field have been mechanically refrigerated automobile trucks; improved refrigerator cars using axle-driven compressors; cars using dry ice, silicate gel, and improvements in the design of water iced cars; refrigerated show cases for merchandising frozen foods; specially designed containers and packages; cold diffusers for storage rooms. In addition, it must be considered that all of this equipment involves compressors, temperature control apparatus, temperature recorders, and other auxiliary apparatus.

CRUDE-OIL airplane motors have been successfully tested on Junkers passenger planes in Germany, and will be applied to ten Lufthansa planes immediately. The new engines can generate 700 hp. with reduced fuel costs and no danger from fire. The chief advantage of the engine is the absence of valves. Instead, two pistons move in opposite directions within each cylinder. When the pistons are apart, a blast of air is admitted through slits. The oil is then sprayed in through nozzles under a pressure of 500 atmospheres, six times the pressure produced within the cylinder by the explosion of the oil.

News of the Metal Markets

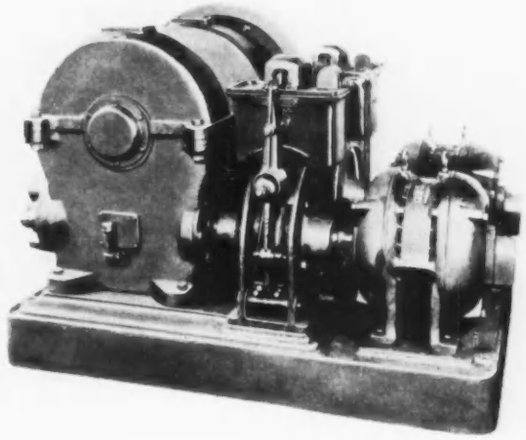
COPPER dropped to 9c., delivered Connecticut, during the first week in May, the lowest price since 1894, according to *Engineering and Mining Journal*. The feeling that the business situation would not change greatly before late in the third quarter was responsible for the depressed state of the market. Actual consumption of copper in 1930, however, was higher than that in 1928, although below that of 1929, according to figures of the American Bureau of Metal Statistics. The largest consumption of copper outside of the electrical industries is in automobiles, wire cloth, castings, radio sets, and refrigerators.

ZINC prices, at 3.25c. on May 7, are the lowest in 35 years, while Straits tin was selling at the lowest level since 1902. The general opinion is that further declines in zinc prices are unlikely because of curtailment of production. Western zinc mines have been cutting production, and a number of mines have shut down until prices advance. Stocks of tin are lower than those reported for last month.

LEAD production in Canada declined during the first part of the year. The New York price on May 7 of 4c. was reported as attracting considerable business, and April shipments were estimated to be fairly normal.

PLATINUM, which finds industrial use as a plating metal and for ignition points, will henceforth be refined on a large scale in England from Canadian ores by the Mond Nickel Company. RHODIUM and RUTHENIUM are also to be derived from the Ontario ores, and it is expected that the new source will not only take the industry from the control of the Russians, but will also serve to make the metals more plentiful.

INDOOR display signs, simulating metals but pressed of impregnated paper at a tenth the cost, are being adopted. At a distance of a few feet, the finish cannot be distinguished from a metal sign



WATSON elevator hoist. Two independently controlled motors having different full-load speed, drive the traction sheave through differential gearing. Thus four full-load speeds are obtainable, those of each motor separately, the sum of their speeds and the difference

Standards and Specifications

SIMPLIFIED Practice Recommendation R17-30 on Forged Tools, submitted to industry under date of Mar. 19, has been accepted by a sufficient number of manufacturers and users to be considered effective as of July 1. R100-29 on Welded Chain, R47-28 on Cut Tacks and Small Cut Nails and R111-30 on Color for School Furniture have been reaffirmed by the standing committees without change for one year. Others being distributed to manufacturers and users include R94-30 on Open-Web Steel Joists, R97-30 on Bell-Bottom Screw Jacks and a proposed revision of F.S.B. 176 on Renewable Cartridge Enclosed Fuses.

The A.S.A. has approved a revision of the specifications for cotton rubber-lined fire hose increasing permissible organic acetone extract to 4 per cent of the rubber compound by weight. The new American Standard Safety Code for Coal Pneumatic Cleaning Plants has also been published.

Standard specifications for paper-base phenolic sheet have been adopted by the National Electrical Manufacturers' Association.

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Engineering Notes

SAMPLES of threaded products are being collected from users of the country to begin a survey of screw-thread practice of the United States, undertaken by the A.S.M.E. Sectional Committee on Standardization and Unification of Screw Threads preliminary to revision of the present American Standard for Screw Threads.

Sessions on aeronautic problems, machine shop practice, design, power, fuels and textiles will be included in the fourth of a series of New England meetings of the A.S.M.E. at Hartford, Conn., June 1-3. Included in papers are "Collapsing Strength of Steel Tubes," "Strength of Thin Cylindrical Shells under External Pressure," "Recent Developments in Airplane Design," "Recent and Future Developments in Aircraft Engines," "Stresses in Dished Heads of Pressure Vessels," "Analysis of Stresses in Circular Plates and Rings with Application to Cylinders with Rigidly Attached Flat Head and Flanges," and "Stresses in Curved Bars."

New data on tooth loading was included in the paper, "Photoelastic Study of Contact Stresses in Gears," at the annual meeting of the American Gear Manufacturer's Association, May 7. New conceptions of gear tooth loading were also included in Earle Buckingham's paper.

At the two-day National Production Meeting of the S.A.E. in Milwaukee May 7-8, four technical papers were presented, "Industrial Material Handling by Power-Driven Trucks," "Nickel Alloys in Automotive Manufacturing," "New Developments in Surface Hardening of Steel and Their Effect on Cost of Production," and "Latest Developments in High-Speed Milling with Tantalum and Tungsten-Carbide Cutters." Developments in the treatment of nickel cast irons were given in one paper, including data on heat-treating automobile body dies and cylinder sleeves.

Greater interest in displays and technical program was shown at the 35th annual meeting of the American Foundrymen's Association in Chicago the week of May 4. Registration ran over 3,500 and exhibitors numbered 167. Increasing importance of the metallurgist in foundry operation, and increasing adaptation of microscopy, photomicrography, and X-ray and Gamma ray methods of casting examination were indicated.

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Diesel-Powered British Battleships

By Paul Wooton
Washington Correspondent

REPORTS from London that the British Admirality has developed plans for 25,000-ton battleships powered by Diesel engines have been received with great interest by naval engineers. Diesel engines on such battleships would be capable of a 25-knot speed and would have a cruising radius of 20,000 miles without refueling. Some naval opinion is dubious as to whether or not battleships of the 25,000-ton class can carry enough protective armor and enough big guns. The British seem to feel, however, that by limiting the guns to the size of 12 in., the problem of protective armor will be solved.

Meetings

American Society of Mechanical Engineers—Calvin W. Rice, Executive Secretary, 29 W. 39th St., New York. Fourth New England Meeting, Hartford, Conn., June 1-4. National Applied Mechanics Meeting and Exhibit, Purdue University, Lafayette, Ind., June 15-16. Meeting of the Society for the Promotion of Engineering Education June 17, 18, 19 there.

American Petroleum Institute—Production Division Meeting, Baker Hotel, Dallas, Texas, June 3-4. Annual Meeting and Exhibition, Nov. 10-12, Stevens Hotel, Chicago. Lacey Walker, Secretary, 250 Park Ave., New York, N. Y.

Institute of Radio Engineers—Annual Meeting and Exhibition, June 4-6, 1931, Hotel Sherman, Chicago. Harold P. Westman, 33 W. 39th St., New York.

National Electric Light Association—Annual Convention and Exhibition, Atlantic City, N. J., Auditorium and Convention Hall, June 8-12. A. Jackson Marshall, Secretary, 420 Lexington Ave., New York, N. Y.

Radio Manufacturers' Association—Meeting and Exhibition, June 8-12, 1931, Chicago, Stevens Hotel. M. F. Flanagan, 32 W. Randolph St., Chicago, Ill.

American Institute of Chemical Engineers—Twenty-Third Semi-Annual Meeting, Swampscott, Mass., June 10-12. Information, 29 W. 39th St., New York.

Society of Automotive Engineers—Summer Meeting, June 14-19, Greenbrier Hotel, White Sulphur Springs, Va. J. A. C. Warner, Secretary, 29 W. 39th St., New York City.

American Society for Testing Materials—Annual Meeting, Stevens Hotel, Chicago, June 22-26. P. L. Warwick, Secretary, 1315 Spruce St., Philadelphia. Testing machines and equipment will be exhibited.

National Metal Congress & Exposition—Exposition on Commonwealth Pier, Congress Sessions at Hotel Statler, Boston, Mass., week of Sept. 21. W. H. Eisenmann, Secretary, A.S.S.T., 7016 Euclid Ave., Cleveland, Ohio.

American Gas Association—Annual Convention and Exhibition, Oct. 12-16, Atlantic City, N. J., Municipal Auditorium. Kurwin R. Boyes, Secretary, 420 Lexington Ave., New York, N. Y.

National Safety Council—Twentieth Annual Safety Congress (Show in Connection), Chicago, Oct. 12-16. Headquarters, Civic Opera Bldg., Chicago.

IN THE SPOTLIGHT—

CONRAD N. LAUER, president of the Philadelphia Gas Works, has been nominated for president of the American Society of Mechanical Engineers. ROBERT M. GATES, vice-president of the Superheater Company, CHARLES M. ALLEN, professor of hydraulic engineering of Worcester Polytechnic Institute, FRED H. DORNER, mechanical engineer, and WILLIAM B. GREGORY, professor of experimental engineering at Tulane University, have been nominated as vice-presidents. ALEXANDER J. DICKIE, editor of "The Pacific Marine Review," EUGENE W. O'BRIEN, editor of "The Southern Power Journal," and HARRY R. WESTCOTT, president of Westcott & Mapes, Inc., have been nominated as managers. Delegates to the American Engineering Council include CONRAD N. LAUER, PAUL DOTY, R. E. FLANDERS, C. E. FERRIS, L. P. ALFORD, J. H. LAWRENCE, R. C. MARSHALL, JR., A. A. POTTER, W. H. TRASK, JR., and E. C. HUTCHINSON. Elections will be by letter ballot of the membership closing Sept. 22, 1931.

C. H. ADAMSON, secretary of the Stephens-Adamson Manufacturing Company, Aurora, Ill., has been placed in direct charge of engineering and sales for the Chicago territory, in the Civic Opera Bldg., 20 North Wacker Drive.

CYRIL AINSWORTH, safety engineer on the staff of the American Standards Association for the past year, has been appointed assistant secretary to succeed F. J. SCHLINK, who resigned recently.

JOHN M. LESSELLS, formerly manager of the Mechanics Division, Westinghouse Research Laboratories, East Pittsburgh, Pa., has been appointed manager of engineering at the South Philadelphia works of the company to succeed A. D. HUNT, resigned.

E. A. DOYLE, consulting engineer of the Linde Air Products Company, and F. P. MCKIBBEN, consulting engineer of the General Electric Company, have been elected president and senior vice-president of the American Welding Society. WILLIAM A. F. MILLINGER of the Shell Oil Company was elected Pacific Coast divisional vice-president and H. C. PRICE of the Welding Engineering Company has been elected Southern divisional vice-president. A. M. CANDY, engineer of the Westinghouse Electric & Manufacturing Company, P. H. DEPPELER, chief engineer of the Metal & Thermit Corporation, D. H. EWERTZ, consulting engineer and A. P. GAYNOR of the John A. Roebling's Sons Company were elected directors at large. DR. C. A. ADAMS, professor of engineering at Harvard University and president of the Welding Engineering & Research Corporation, was elected director of the American Bureau of Welding, and H. M. HUBART, chief engineer of the General Electric Company, was re-elected vice-director. J. H. CRITCHETT, head of the Research Department, Union Carbide & Carbon Research Corporation, was also elected a director.

HAROLD E. ANDERSON, formerly of the commercial-car engineering department, Studebaker Corporation of America, South Bend, Ind., has joined the experimental department of the Oakland Motor Car Company, Pontiac, Mich.

THOMAS BACKUS, formerly designing engineer on transmissions and clutches of the Fuller & Sons Manufacturing Company, a division of the Unit Corporation, Milwaukee, is now a designer with the Brown-Lipe Division, Spicer Manufacturing Corporation, Toledo.

E. H. BALLARD, general foundry & pattern shop superintendent of the General Electric Company, at the West Lynn (Mass.) Works, has been elected president of the American Foundrymen's Association. T. S. Hammond, president of the Whiting Corporation, has been elected vice-president of the Association. Directors for a three-year term include N. K. B. PATCH, secretary of the Lumen Bearing Company, FRED L. WOLF, chief engineer and technical superintendent of the Ohio Brass Company; W. D. MOORE, president of the American Cast Iron Pipe Company; A. G. STORIE, Fittings Ltd., Oshawa, Ont., and DAN M. AVEY, editor of "The Foundry."

WALTER E. BATTLES has been promoted from mechanical draftsman to engineer with the Pfaudler Company, Rochester, N. Y.

John M. Lessells

E. A. Doyle

J. J. BAUM, formerly with the Ohio Steel Foundry Company, Springfield, has been appointed head of the Development Engineering Department, Steel Founders' Society of America, New York.

J. G. BENEDICT, president of the Landis Machine Company, was re-elected president of the National Metal Trades Association by unanimous vote at the recent meeting, as was JACOB D. COX, JR., of the Cleveland Twist Drill Company, first vice-president, and J. W. O'LEARY of the Arthur O'Leary & Son Company, treasurer. ALEXANDER SELLERS of William Sellers & Company was elected second vice-president.

OSCAR C. BORNHOLT, formerly research engineer with the Houdaille-Hershey Corporation, Chicago, has been elected vice-president of the Fulton Company, Milwaukee.

CAPT. HAROLD G. BOWEN, United States Navy, has been detached from duty at the Navy Yard, Puget Sound, Washington, and appointed Assistant Chief of the Bureau of Engineering, Navy Department. He will report for duty about July 6, relieving CAPT. IVAN E. BASS, who has received orders as aide on the staff of the Commander-in-Chief, Asiatic Fleet.

RALPH C. CHESNUTT, formerly experimental engineer with the Marmon Motor Car Company, Indianapolis, has become experimental engineer with the Cleveland (Ohio) Tractor Company.

FRED CLIFFE, designer with the Tecalemit Company, Ltd., Brentford, Middlesex, England, has been appointed chief engineer.

W. CHAPIN CONDIT, formerly automotive research engineer with the Standard Oil Development Company, Elizabeth, N. J., has become a research engineer with the Sun Oil Company, Marcus Hook, Pa.

W. A. DELMAR of the Habirshaw Electric Cable Company, Yonkers, N. Y., has been named chairman of the Sectional Committee on Insulated Wires & Cables of the American Standards Association. F. J. WHITE of the Okonite Company, 501 Fifth Ave., New York City, is secretary.

A. W. HERRINGTON, consulting engineer of the City of Washington, has been made vice-president and chief engineer of the recently organized Marmon-Herrington Company, Inc., which will manufacture multiple-drive motor-trucks of a specialized type designed by Mr. Herrington. The new company is a subsidiary of the Marmon Motor Car Company, Indianapolis, and will operate in the Marmon plant.

R. C. ROLFING, vice-president of the Oliver Farm Equipment Company, Chicago, in charge of manufacturing and engineering, has resigned and will spend several months traveling.

WALTER TREFZ, formerly sales engineer with the Climax-Jones & Quinn Company, Inc., St. Louis, has become an experimental engineer with Aluminum Industries, Inc., Cincinnati.

KENNETH S. CULLOM, previously with the E. W. Bliss Company, Brooklyn, N. Y., as mechanical engineer in aircraft-engine production, has become test engineer in the aircraft-engine department of the Glenn L. Martin Company, Baltimore.

F. M. FARMER, representing the A.I.E.E. and the A.W.S., has been appointed chairman of the American Standards Association's Sectional Committee on Electric Welding Apparatus.

C. W. GIVEN, formerly on the laboratory staff of the Ferro Corporation, Cleveland, has been appointed service engineer for the Michigan Steel Corporation, Detroit.

FELIX HAAS has become a designing and development engineer for shop machinery with the Superheater Company, East Chicago, Ind.

E. L. RYERSON, JR., president of Joseph T. Ryerson & Son, Inc., Chicago, has been chosen to represent the American Engineering Council on the Advisory Board of the Museum of Science and Industry in the City of New York.

PROF. EARLE BUCKINGHAM of the Massachusetts Institute of Technology spoke on "Strength and Durability of Spur Gear Teeth" at the Fifteenth Annual Meeting of the American Gear Manufacturers' Association at the Hotel Statler, Buffalo, May 7-9. C. W. MANSUR of the Plastics Department, Gear Division, General Electric Company, spoke on "Non-Metallic Gears and Their Operating Characteristics."

S. M. KINTNER, assistant vice-president of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has been elected vice-president in charge of engineering to succeed W. S. RUGG, who becomes vice-president in charge of sales.

STRICKLAND KNEASS has resigned as chief engineer of the A. M. Byers Company, Pittsburgh, to join the Leif Lee Company, Pittsburgh, manufacturer of heating and ventilating equipment.

A. W. MOONEY, formerly president of the Mooney Aircraft Corporation, Wichita, Kansas, has become an aeronautic engineer for Nicholas Beazley at Marshall, Mo.

HAROLD F. PITCAIRN and his associates of the Pitcairn-Cierva Autogiro Company of America, Philadelphia, has been awarded the Collier Trophy for 1930 for "the greatest achievement in aviation in America, the value of which has been demonstrated during the preceding year."

G. H. GARCELON has been appointed manager of the Control Engineering Department, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., to succeed J. H. BELKNAP, who has been transferred to the engineering division of the Pittsburgh district office. Mr. Garcelon was formerly manager of engineering for the company's works at East Springfield, Mass., and has been with Westinghouse since 1903.

WESLEY LAMBERT, past president of the Institute of British Foundrymen, and a member of the Council of the Institute of Metals, has resigned as manager of the Metallurgical Department, J. Stone & Company, Ltd., Deptford & Charlton, England, but will continue in an advisory capacity.

M. B. MACNEILLE, formerly designing engineer of centrifugal pumps, chief engineer of the hydraulic division, and for the past six years manager of the pump division of Fairbanks, Morse & Company, Chicago, has resigned to become Western sales manager of the Dayton-Dowd Company, Quincy, Ill., with headquarters in San Francisco.

MERRIT A. MIERAS, formerly engineer on engine installations of the Detroit Aircraft Corporation, has joined the Burgess Battery Company in its Detroit office in a sales and engineering capacity.

JULIUS MULLER, formerly with the Henry Vogt Machine Company, Louisville, Ky., has become development engineer for the Leeds & Northrup Company, Philadelphia.

LEONARD OCHTMAN, JR., previously chief engineer of the Elco Works of the Electric Boat Company, Bayonne, N. J., has become engineer for the S. R. Dresser Manufacturing Company, Bradford, Pa., in connection with the development of new products.

Earle Buckingham

Harold F. Pitcairn

The illustrations on these two pages are copper etchings produced by a new process and shown for the first time here

GEORGE A. ORROK, DAVID MOFFAT MYERS, and W. A. SHOUDY, consulting engineers, have moved their offices to 21 East 40th St., New York City.

E. D. POWER, manager of the Automotive Division, Lyon Metal Products Company, Aurora, Ill., has been made director of research.

CHARLES W. STAPLES, formerly associate engineer with the United States Bureau of Standards, Washington, D. C., has accepted a position as research engineer with the Vacuum Oil Company, Paulsboro, N. J.

WALTER H. TITSCH, formerly engineer with the Rolls-Royce of America, Springfield, Mass., has joined the Packard Motor Car Company, Detroit, in a similar capacity.

FRANK THORNTON, JR., manager of resident engineers in the General Engineering Department, Westinghouse Electric & Manufacturing Company, East Pittsburgh, has been appointed manager of association activities of the Engineering Department.

J. R. TOWNSEND, Bell Telephone Laboratories, and T. T. EDGERTON, Crucible Steel Company of America, have been announced as chairman and secretary of the A.S.M.E. Special Research Committee on Mechanical Springs.

EDWARD C. WENTE, acoustical research engineer of the Bell Telephone Laboratories, New York City, has been awarded the John Price Wetherill medal of the Franklin Institute, for his invention of the condenser transmitter.

F. C. SPENCER, Western Electric Company, has been confirmed as chairman of the A.S.M.E. Special Research Committee on the cutting of metals by the Main Research Committee of the Society. He succeeds W. W. NICHOLS.

T. P. WRIGHT, chief engineer of the Airplane Division, Curtis Aeroplane & Motor Corporation, has been awarded the Wright Brothers Medal presented annually to the "author of the best paper on aerodynamics or structural theory or research, or airplane design or construction, which shall have been presented at a meeting of the S.A.E."

Obituaries

DANIEL H. DEYOE, 55, of the Industrial Engineering Department of the General Electric Company, a director and member of the American Welding Society and a figure for many years identified in electric arc-welding activities, died in Schenectady, April 11.

HENRY MURRAY CAMERON, 53, chief naval architect and chief estimator of Canadian Vickers, Ltd., Montreal, died at his home there April 10. Mr. Cameron was former manager of Canadian Vickers, Ltd., in Montreal, as well as former manager of the Vicker plant in Lancashire, England.

WILLIAM T. NORTON, 51, designer of the war-time Liberty truck, and since 1923 a consulting automotive engineer in Cleveland, died recently there.

NEW MATERIALS AND PARTS AND ENGINEERING EQUIPMENT

"Farval" Improved Dualine Lubrication System

Several improvements have been made in the "Farval Dualine System of Lubrication" developed by Lubrication Devices, Inc., Battle Creek, Mich. The previous announcement appeared on page 396 of the August 1930 number. This system is designed to provide a positive distribution of heavy-duty compounds and mill greases. It is intended especially for the lubrication of steel, cement, paper, sugar, and rubber mill equipment. It has but one electrically driven central pumping unit, which supplies lubricant at high pressure to both supply lines. Delivery of lubricant to one supply line loads all of the valves with a measured quantity of lubricant. The other supply line discharges each valve.

A four-way, hydraulic reversing valve controls the delivery of the lubricant. This valve may be either electrically or manually operated. When electrically operated, the motor is controlled by an electric time clock, which can be set to operate at any interval from 2 min. to 2 hr. Final shut-off of the pumping unit is accomplished through the control valve located at the end of the line. This method insures the positive delivery of pressure throughout the entire system before the control valve functions.

The Farval valve is fully automatic and the adjusting screw is calibrated to indicate the travel of the large primary piston. It is so designed that the discharge may be reduced to one-fifth of capacity.

A large hopper-type reservoir of 550-lb. capacity is furnished, being complete with the necessary connections for filling from the standard drum pump, and provided with a connection for compressed air to assist in the handling of heavy greases.

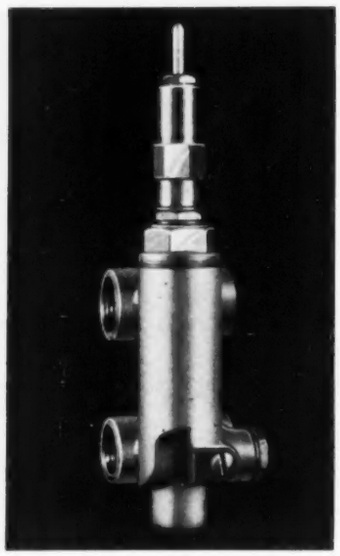


Fig. 1—Farval Valve for the Dualine System of Lubrication, showing the indicating rod

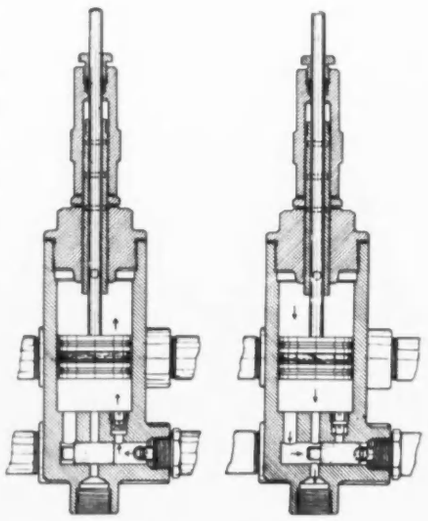


Fig. 2—Left—Pressure applied to the loading line of the Farval valve. Right—Pressure applied to the shooting line.

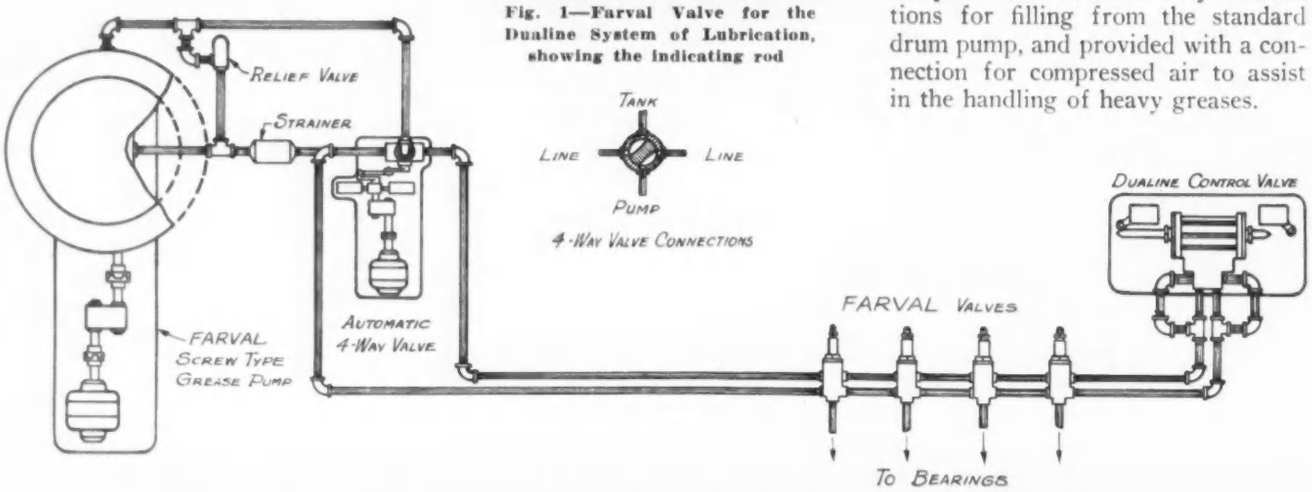
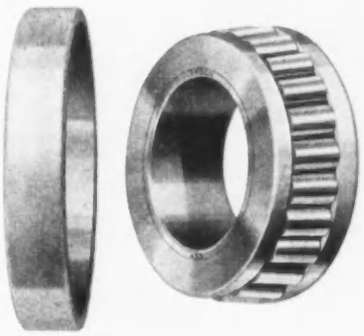


Fig. 3—Layout of Farval Improved Automatic Dualine System of Lubrication, showing the control valve at the end of the line for final shut-off of the pumping unit after the system has functioned

Tyson Cageless, Tapered Roller Bearings

Cageless, tapered roller bearings interchangeable with conventional ball and tapered roller bearings have been placed on the market by the Tyson Roller Bearing Corporation, Massillon, Ohio. Positive roll alignment is attained by the use of a double-ribbed backplate at the big end of the rolls, thus doing away with the necessity for a cage. The shoulder



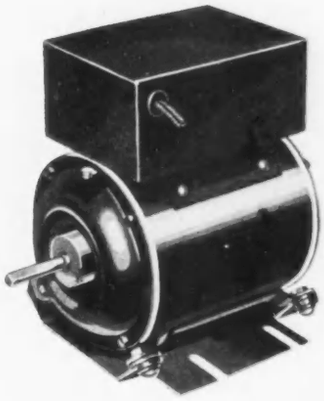
of each roll gets a bearing on the inside rib of the backplate, as in other tapered roller bearings, but it also gets an additional bearing on the outside rib. Thus, with double contact on the thrust end of each roll, positive alignment, both longitudinally and vertically, is secured. Pintles at both ends of the rolls, extending into the annular grooves in the backplate and the closing ring, hold the rolls in place when the cup is removed. Omission of the cage from the bearing leaves room for from 20 to 50 per cent more rolls.

The double backplate contact of the rolls, plus a raceway filled with tapered rolls, means that no roll can get out of place or overlap when operating at high speed. Positive line contact of rolls on the cone is inherent. The bearings are made in all S.A.E. sizes.

Howell Type CI Motors

A complete line of fractional-horsepower motors from $\frac{1}{16}$ to $\frac{1}{3}$ hp. has been placed on the market by the Howell Electric Motors Company, Howell, Mich. This line consists of condenser start, split-phase, and polyphase motors, all built to the same frame dimensions.

The condenser motor has the condenser mounted in a compact box at the top with all connections made inside. It may, however, be mounted on the side of the motor or at any convenient place on the driven appliance, or on the wall. The condenser



Howell Type CI Condenser-Type, Fractional - Horsepower Motor

motors are the high-starting-torque, constant-speed type, having at full voltage a starting torque of from 300 to 400 per cent of full load torque, and a maximum running torque of at least 200 per cent. They are of squirrel-cage construction and are without a commutator or wound rotor.

The split-phase motors are built in the same frames as the condenser motors, and are built to conform to both the short-term and long-term ratings. They are built with either ball or sleeve waste-packed bearings.

Oilgear Type WES Constant-Pressure Pumps

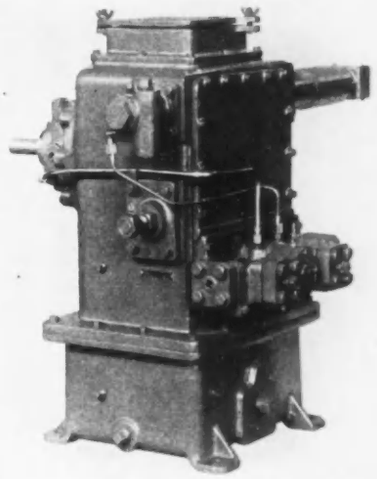
THREE styles of the Type WES constant-pressure pumps are being manufactured by The Oilgear Company, 647-683 Park St., Milwaukee, Wis. These styles are the Type WES-5, the Type WES-6, and the special Type WES-6.

The Type WES-5 pump has a maximum displacement of 3,600 cu.in. of oil per min. when operated at a constant speed of 860 r.p.m. This pump can be used on applications where any pressure up to and including 1,000 lb. per sq.in. is required for intermittent or continuous operation, without loss of power or excessive heating of the oil. A peak pressure of 1,500 lb. per sq.in. is available for short intermittent operation.

The type WES-6 pump has a maximum displacement of 3,400 cu. in. of oil per min. when operated at a constant speed of 600 r.p.m. This pump can be used on applications where any pressure up to and including 1,000 lb. per sq.in. is required for intermittent or continuous operation. A peak pressure of 1,500 lb. per sq.in. is available for short intermittent operation.

The special type WES-6 pump has a maximum displacement of 4,800 cu.in. of oil per min. when operated at a constant speed of 860 r.p.m. This pump can be used on applications where any pressure up to and including 1,000 lb. per sq.in. is required, for intermittent or continuous operation. The maximum pressure available with this unit is 1,000 lb. per sq.in.

The pumps described are equipped with automatic constant pressure type controls, whereby the maximum pressure can be maintained indefinitely without overheating, loss of power, or attention by the operator. The pressure can be released instantly by simply bypassing the oil. A peak pressure relief valve installed inside of the pump casing



Oilgear Type WES Constant-Pressure Pump, equipped with a standard small oil pot, which is used for mounting the unit

protects the work, machine, and pump against overloads. An oil reservoir is flanged to the pump casing and is also equipped with a suitable lug for mounting the pump. Any constant speed source of power can be used for the pump drive. The highly finished working parts are all lubricated under pressure, while all thrusts are carried on ball and roller bearings. A small auxiliary gear pump built into the drive

NEW MATERIALS AND PARTS

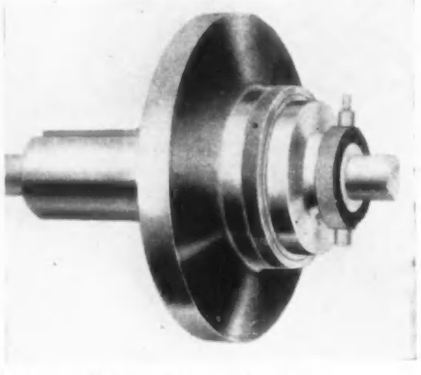
shaft end casing supercharges the high pressure unit at all times.

The power required for these pumps is in direct proportion to the work to be performed. Maximum requirements are 15 hp. A 7½- or 10-hp. motor is sufficiently large for most installations. The capacity of the oil reservoir is 4½ gal., and the net weight of the pump is 600 lb.

"Diamond-D" Friction Clutch

A completely inclosed disk clutch designed primarily for machinery applications, but adaptable for power transmission service, is being offered by the Dodge Manufacturing Corporation, Mishawaka, Ind. While large friction area is provided to insure the full rated horsepower being transmitted under moderate unit pressures, over-all compactness of dimensions has been attained. In both the engaged and disengaged positions the clutch is fully inclosed, assuring safety as well as protection against dust and dirt.

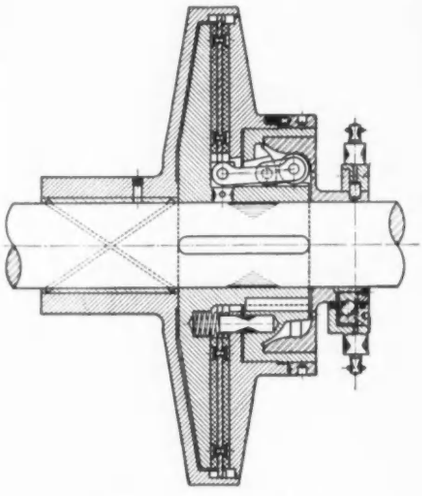
As the cross-sectional view shows, the clutch consists of a laterally free friction disk capable of being clamped between two heavy steel disks, one or which is keyed to the central shaft, which may be either the driving or driven member. At its periphery the friction disk engages through interlocking serrations and slots the other rotating member in the form of a sleeve with a conical bell end. The sleeve has a key slot for attachment



Dodge "Diamond-D" Friction Clutch in disengaged position

to a pulley, gear, or sprocket hub. Compression of the disk between the clutch faces is by three toggle members actuated by an internal cam of cylindrical form, which is moved lengthwise on the shaft by means of a slip ring and shifting yoke.

The friction disk consists of two ground asbestos disks riveted to a



Cross-section showing clutch in the engaged position

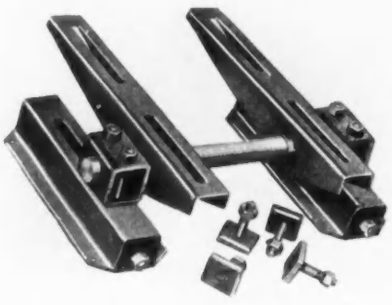
steel plate through which the torque is transmitted at its periphery. Either a heavy bronze slip ring or ball bearing unit is offered, both lubricated through a compression fitting in the yoke arm. The toggle is self-locking in the closed position, and in the open position the plates are kept free by coil springs, plus the centrifugal action of the toggle mechanism. Contact between the cam and toggles is through hardened steel rollers. Adjustment of the clutch is by a knurled self-locking ring, which, through the medium of a threaded sleeve, adjusts the distance between the two steel compressing disks. Movement of the slip ring is constant and is not affected by wear of the friction material or adjustment.

All parts are held to close tolerances to insure accurate assembly, balance, uniform throw, convenient adjustment, and interchangeability. All wearing members are hardened and ground.

Kritzer Floating Motor Drive

Short-center drives, either flat belt or V-belt, can be evolved with the floating motor drive announced by The Kritzer Company, 515 West 35th St., Chicago, Ill. With this type of mounting the driving motor floats on the load, maintaining just sufficient tension on the belt to carry the load. The nominal increase in belt length

Kritzer Drive which has the motor pivotally mounted so that the torque regulates belt tension



Kritzer Pivoting Motor Base Assembly

during the operation is automatically compensated for without idlers.

With this drive the weight of the motor is balanced and the motor torque regulates the belt tension. The weight of the motor does not hang on the belt. Thus, the heavier the load on the belt, the greater the torque reaction on the frame and the greater the tension on the belt. The mounting is made of pressed steel and the pivot shaft is bronze bushed. Bases for motors from ½ to 25 hp. are carried in stock.

Landahl Shaft Backstop

Shaft reversal is prevented by employment of the Landahl backstop manufactured by The Fairfield Engineering Company, Marion, Ohio. Besides acting as a backstop, the device is also suitable as a bearing. It eliminates shaft end thrust in either direction so that no separate set collars are required. No extra shaft space is taken up as the device requires only the space of a standard type bearing.

The internal construction of the Landahl backstop consists of two locking pawls mounted on pins that are held by two floating rings and a pawl collar. All of these parts ro-

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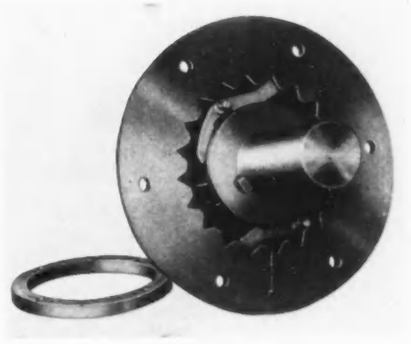
tate as a unit by engagement of the pawls with the pawl collar. The latter is shaped so that the pawls do not engage the rachet so long as the shaft is traveling in the correct direction, but lock in the ratchet immediately that the direction of shaft rotation reverses. Both a key and setscrew are employed to fasten the pawl collar rigidly to the shaft. The floating rings are seated in the ratchet housing, but are free to rotate with the pawls and the collar. All working parts operate in an oil bath. Lubrication for the housing ends,



Landahl Shaft Backstop, built in shaft sizes from $1\frac{7}{16}$ to $7\frac{1}{4}$ in.

which serve as the shaft bearings, is provided by means of oil grooves running from the central oil bath. The housing is made in two parts bolted together and provided with paper shims to keep it oil-tight.

This backstop is built in two styles, both of which can be attached readily to framework or housings by simply using longer bolts in place of the regular housing bolts. Style *A* is furnished with a plain flange bearing and style *B* with a pedestal-type bearing. Shaft sizes range from $1\frac{7}{16}$ to $7\frac{1}{2}$ in., thicknesses from $4\frac{1}{2}$ to $22\frac{1}{2}$ in., and over-all diameters from $6\frac{3}{4}$ to $27\frac{3}{4}$ in.

Daun-Walter Constant-Level Oil Control

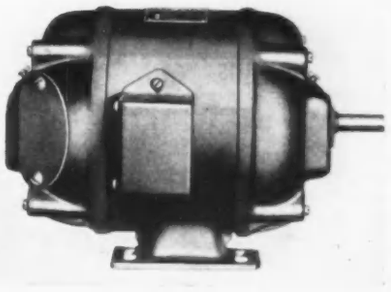
Regulation of the lubrication of machine bearings and ways can be accomplished by the constant-level oil control announced by the Daun-Walter Company, 334 East Water St., Milwaukee, Wis. The device consists of a main reservoir with gage to show the height of oil in the reservoir, a supporting bracket, a threaded lower extension for the oil lead connection, and a filling cap on the top. Through the influence of gravity and

Daun-Walter Constant-Level Oil Control, built in sizes to 2 gal.

atmospheric pressure, oil is supplied to the bearing when and as it is used. The delivery of oil is automatic and is constantly controlled without the use of floats or other means. Correct oil levels are easily and permanently maintained by adjustment on the attaching bracket. The oil can be piped to feed one or several bearings on the same level, or in connection with a special adjustable wick unit, single or multiple bearings on different levels can be fed. The unit is made with oil reservoir capacities ranging from $\frac{1}{2}$ pint to 2 gal.

Century Fractional-Hp. Motors

Interchangeable mounting dimensions are now featured in the line of fractional-horsepower motors built by the Century Electric Company, St. Louis, Mo. These motors include the following types: single-phase, repulsion-start, induction type; split-phase, single-phase type; and squirrel-cage, induction three-phase type, and the d.c. type. The bearing brackets



offer protection against falling objects, dirt, and dripping water. The motors have rolled steel frames and welded steel feet, the latter slotted for belt adjustment.

These interchangeable, fractional-horsepower motors are made in 60-, 50- and 25-cycle models. The 60-cycle motors are built in $\frac{1}{6}$-, $\frac{1}{8}$-, and $\frac{1}{4}$-hp. sizes in four frame styles; the 50-cycle motors in $\frac{1}{6}$- and $\frac{1}{4}$-hp. sizes, and the 25-cycle motors in $\frac{1}{6}$-hp. sizes.

Ruthman Grinder Pump

For incorporation in grinders and other equipment where excessive abrasive material is present in the coolant, the Ruthman Machinery Company, Cincinnati, Ohio, has developed the pump illustrated. The rotor shaft is supported by two heavy-

duty ball bearings and extends into the pump housing to carry the impeller. The impeller is designed to prevent clogging. An intake strainer has been provided integral with the base casting to eliminate injury to the impeller through the action of grit. The openings of this strainer are large enough to allow free passage of the liquid, but are sufficiently small to prevent large particles of waste or abrasive material from entering the intake. The pump requires no packing, felt washers, or close fits of any part coming in contact with the grinding compound. Ample room is allowed between the impeller and the

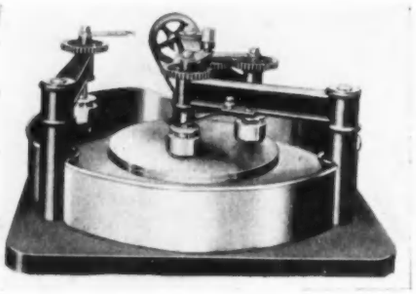
NEW MATERIALS AND PARTS

housing to permit foreign matter to pass through freely.

The upper end bell, or motor bearing flange, of this pump is totally inclosed, thereby preventing dirt and drippings from getting into the motor. Wiring leads project through a conduit box mounted on the side of the motor frame for greater safety. The pump can be furnished both for immersed and outside installations and in sizes ranging from ¼ to 5 hp.

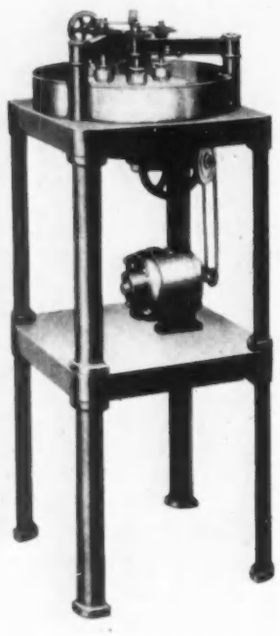
"Aminco" Polishing Machine for Metallographic Specimens

Three specimens for metallographic investigation are polished automatically by the "Aminco" polishing machine developed by the American Instrument Company, Inc., 774 Girard St., N. W., Washington, D. C., from a design of the Bureau of Standards. The polishing head is covered with a suitable polishing cloth and this head is mounted on a vertical spindle driven by a belt from the motor below. Specimen holders float on the polishing cloth and change their positions slightly as the contour of the cloth changes. The specimens are held tightly against the cloth by spring rods which bear on the specimen holders. At the top of each specimen spindle is a rigidly attached gear, which meshes with an eccentric



Close-up of polishing head, showing the three specimen holders, which are caused to rotate and oscillate on the polishing cloth by means of an eccentric gear

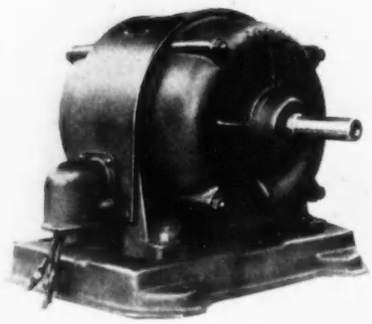
gear. This eccentric gear is driven through a speed reducer and causes the three specimen-holder gears to rotate. Besides rotating on their axes, these holders oscillate toward and away from the center of the disk, giving uniform results on all three metallographic specimens.



"Aminco" Automatic Metallographic Polishing Machine

"Ideal" Drip-Proof Motor

An addition to the line of unit-type motors, manufactured by The Ideal Electric & Manufacturing Company, Mansfield, Ohio, is the drip-



proof motor, which is protected against water or other liquids dripping on it or being splashed in through the ends. When water is thrown into the motor, it is discharged immediately through the vent at the bottom of the center inclosing jacket. Air circulation is from both ends toward the center and out through this vent. Large shrouded fans located just inside the end brackets produce the action which discharges the water. These fans throw the water against the inside surface of the bearing bracket. From here, the water runs down the inside of the bearing brackets and out through the center bottom vent without coming in contact with the windings.

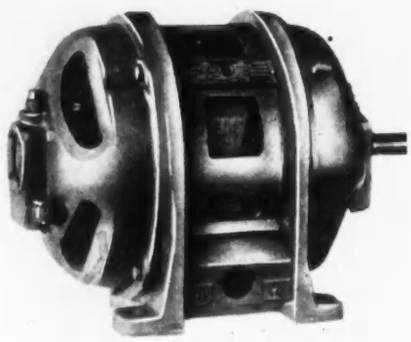
The insulation is such that an occasional wetting will not have any serious effect. The strong blast of air is sufficient to evaporate any water that may reach the windings.

The outer surfaces of the Ideal drip-proof motor are such that water dripping from above cannot enter the motor. The end bearing brackets are so shaped that water dripping on them travels around the end and to the base without entering the motor.

Westinghouse W-Frame, Type CS Squirrel-Cage Motor

In the design of the W-frame, Type CS, squirrel-cage, induction motor, the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has incorporated an innovation in motor design: making the different parts of the motor as entirely separate units. Thus, the company has only to keep the number of standardized parts in stock to be able to build, on short notice, a motor for a specific application. The design makes maintenance simpler and less expensive.

In the W-frame motor, the stator core containing its winding is pressed into the motor frame. When it becomes necessary to replace the damaged winding, the old core and its winding is pressed out as a unit, and a new "pre-wound" core is pressed



in. The entire operation can usually be performed in less than an hour.

Like the stator core and its winding, the rotor is a complete separate unit, and both the rotor and the stator core and their windings can be supplied as such for built-in motor or repair purposes. This feature makes it possible to vary the electrical characteristics, using the same parts.

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The separate-frame construction makes it possible to supply any one of a number of different types of frames to meet the needs of the customer. The brackets are bolted to the frame with a ring-groove fit that automatically and permanently sets the air gap and aligns the bearings.

Lukens Nickel-Clad Steel Plate

Hot rolled plate made up of a layer of pure solid nickel and a heavier layer of high-grade flange steel is now being manufactured by the Lukens Steel Company, Coatesville, Pa. In the hot rolling process the pure nickel is bonded or welded to the steel. The product is available in all sizes of plates $\frac{1}{4}$ in. thick and heavier, and in all grades in which the solid nickel is 10 to 20 per cent of the thickness of the nickel-clad steel plate. Flanged and dished heads are also available.

This nickel-clad steel plate makes feasible heavy plate construction jobs where both corrosion resistance of the equipment and non-contamination of the product are desired, such as in the food and chemical industries. In such construction it is necessary to maintain a continuous nickel surface. The methods of welding and riveting, or combinations of both, that have been developed in the construction of the tank cars, evaporators, tanks, mixer bodies, and others have proved satisfactory. The plate has the same corrosion-resisting properties as pure nickel, as distinct from nickel electroplate. Under proper fabricating control this corrosion-resistance can be relied upon until the nickel plate disappears by corrosion or wear.

"Bundyweld" Copper-Lined Steel Tubing

A double-walled steel tubing with a copper lining has been placed on the market by the Bundy Tubing Company, 4815 Bellevue Avenue, Detroit, Mich. As shown by the accompanying illustration, this "Bundyweld" tubing is formed of copper-coated strip steel laterally rolled over stationary arbors into a double-walled tube. The tube is then passed through an electric furnace employing a hydrogen atmosphere and the copper is brazed to the steel at the joints. Inside and outside dimensions are held to tolerances as close as 0.003 in. A clean inside surface is secured, the copper lining affording corrosion

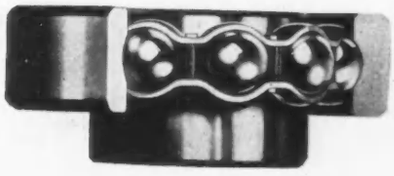
Cross-section of "Bundyweld" Double-Walled, Copper-Lined Tubing, available in sizes from $\frac{1}{4}$ to $\frac{5}{8}$ in.

resistance and preventing scale formation. The copper-coated outer surface can be finished in polished nickel, chromium-plating or other desired finishes.

Bundyweld tubing is obtainable in sizes from $\frac{1}{8}$ to $\frac{5}{8}$ in. Ductility of the tube is such that any desired bend can be made. Standard types of fittings can be employed. The tubing is applicable to automotive use for oil and gas lines, hydraulic brake lines, conduit and windshield wiper tubes; electric refrigerators for condensers and connections, and many other uses.

"Standard" Wide-Inner-Ring Single-Row Ball Bearings

Standard Steel & Bearings Inc., Plainville, Conn., announce the type SRB wide-inner-ring, single-row ball bearings of the same design and dimensions as the single-row maximum capacity bearings, except that the inner ring has the same width as that of the double-row bearing of corresponding sizes. The additional width of the inner ring permits the bearing to be used without a locknut, thus effecting a saving in the cost of the product upon which they are employed. This type of bearing is offered for electric motors and other applications where only a locating or nominal thrust is present. It is available in sizes 303 to 312, inclusive.



"Rite-Lo-Speed" Ball-Bearing Motor

J. D. Christian-Engineers, 512 Brannan St., San Francisco, Calif., has developed a "Rite-Lo-Speed" motor that embodies a standard footless stator and rotor and heat-treated alloy steel helical gears. These gears are ball bearing mounted so that the entire assembly is scarcely larger than the motor itself. The gear end of the assembly, or speed reducer end, embodies only two gears and two pinions. It is so arranged that a heavy overhung pull can be taken on the final shaft without the use of an outboard bearing. The oiling case is sealed from the motor and the entire assembly is protected by a dirt-proof and water-proof housing.

The Rite-Lo-Speed motor-speed reducer is manufactured in four series. Series A is standard, comprising the motor and housing with a single power take-off. Series B is a single motor unit with a gear housing at each end thus having two power take-offs at the same speed. Series C is the same as Series B with the exception that it has two power take-offs at different speeds. Series D is a single motor unit with a gear housing at one end with power take-off at reduced speed, and with high-speed motor shaft extended through the rear end bell. The motor is made in sizes from 1 to 30 hp., and a junior model is made in sizes from $\frac{1}{4}$ to 1 horsepower.

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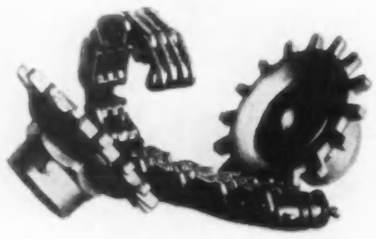
Morse Midget Coupling

The Midget coupling, placed on the market by the Morse Chain Company, Ithaca, N. Y., is a miniature counterpart of the chain-and-sprocket coupling described on p. 91, Vol. 1.

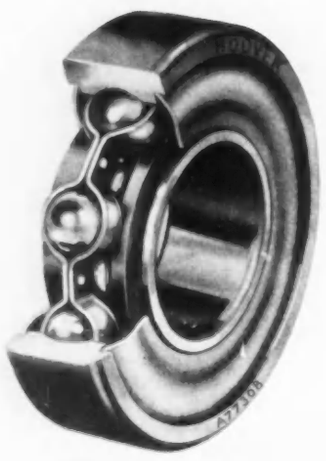


The Midget likewise employs two sprockets wrapped by a chain. It is offered for shaft sizes up to 1 in. in diameter and is of all-steel construction.

Hoover "Duoseal" Ball Bearings

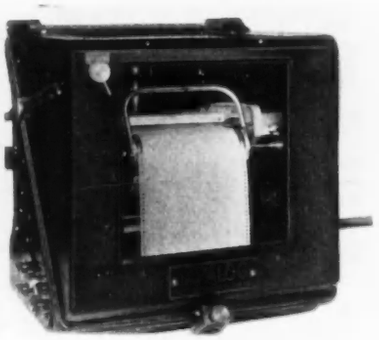
A double "Lubriseal" bearing under the trade name of "Duoseal" has been announced by the Hoover Steel Ball Company, Ann Arbor, Mich. The Duoseal bearing consists of the standard Hoover annual bearing with stamped metal plates on each side of the raceway. These plates are fitted tightly to the outer ring and remain stationary with it. The other edge of the plate fits a special groove in the inner ring, allowing it to turn freely with the shaft and at the same time maintaining an effective seal. Thus the bearing is effective in preventing leakage of grease to other parts of the machine where lubricants are detrimental to its operation, as well as assuring correct lubrication of the bearing by retaining the oil or grease within the raceways. The metal plates of the Duoseal bearing also exclude dirt, dust, and grit and harmful abrasives from the raceways.

Duoseal bearings are packed with grease when shipped and need additional lubrication only once or twice a year. They are available in standard S.A.E. sizes.



"Tapalog" Recording Pyrometer

Recording pyrometers for single and multiple records, and of improved design, have been placed on the market by the Wilson-Maeulen Company, Inc., 383 Concord Avenue, New York, N. Y. These instruments, known under the trade name of "Tapalog," are operated by an industrial-type synchronous electric clock motor. Multiple-record instruments have a faster cycle of record, so that each record is recorded with greater frequency. All models have automatic electric cold junction compensation. Recording pyrometers employing thermocouples, and electric resistance thermometers employing electric resistance bulbs, of both single- and multiple-record types, are now offered in this series.



"Perm-Brite" Aluminum Alloy

An aluminum alloy which tests have so far proven to be non-corrodible in the atmosphere, in sea-water and in many different acids, and known as "Perm-Brite," has been announced by the Apex Smelting Co., 2554 Fillmore St., Chicago. Besides corrosion resistance, it combines other factors of light weight, high strength and fine surface which lends itself readily to polishing and plating. It is adapted to both sand and die castings and can be rolled, forged, drawn, and hot and cold worked. Investigations are now being conducted in the extrusion process.

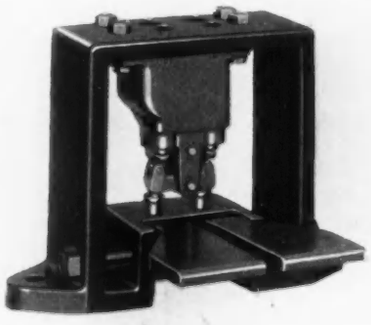
Without heat-treating, Perm-Brite has a yield point of 10,000 lb. per sq.in. and a tensile strength of 24,000 to 26,000 lb. per sq.in. Its Brinell hardness ranges from 50 to 60 (500 kg. load—10 mm. ball). In the cast condition, elongation is 6 to 8 per cent in 2 in. and up to 23 per cent in the rolled state.

The specific gravity is under that of pure aluminum or aluminum alloys of the silicon group, being 2.62. The weight per cu.ft. is 163 lb. or 0.094 lb. per cu.in. Compared with annealed copper, its electrical conductivity is 28 per cent.

At present Perm-Brite is being used for spandrels and other architectural applications, for cooking utensils, marine castings, and hospital apparatus. Patents now pending on Perm-Brite cover the alloy itself and its various applications.

Ross Operating Valves

Foot- and hand-controlled operating valves for pneumatic control mechanisms have been developed by the Ross Operating Valve Company, 6488 Epworth Blvd., Detroit, Mich. The foot-operated valve is made in two styles, models D.T. and S.T. The model D.T. is made in three sizes, $\frac{3}{8}$-, $\frac{1}{2}$- and $\frac{3}{4}$-in. pipe sizes, and is mounted in sturdy brackets. Foot treadles are of cast steel, and all pins, levers, and rockers are hardened to assure long wear. This model is illustrated in the accompanying photograph. The model S.T. is made in



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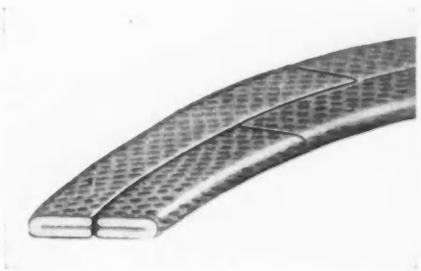
five sizes, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{4}$, 1, and $1\frac{1}{4}$ in. It is offered for double-acting cylinders.

The hand-operated valve is made in five sizes—$\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{4}$, 1, and $1\frac{1}{4}$ in.—for single- and double-acting cylinders and in locking or non-locking types.

Garlock Asbestos-Gasket "Button Hole Tape"

Asbestos gasket material, under the name of "Button Hole Tape," is being manufactured by the Garlock Packing Company, Palmyra, N. Y. The material, constructed to replace asbestos tape on locomotive front ends and on flanged tanks of large diameter, is made up of two parallel courses of folded asbestos cloth,

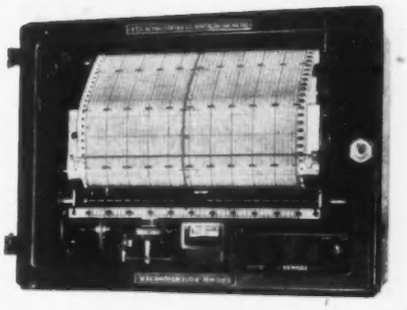


joined together by a single ply of bonding fabric. As shipped from the factory it contains no holes. Insertion of a knife blade between the sections cuts the bonding fabric, forming a button hole which slips readily over a bolt or stud.

The tape is furnished printed with 1-in. graduation marks. The material is manufactured in coils of any desired length, and in all regular widths and thicknesses.

Brown Potentiometer Pyrometer

Many improvements have been made in the potentiometer pyrometer built by The Brown Instrument Company, Philadelphia, Pa. This instrument is available in indicating, recording, multiple recording, and controlling types and embodies some 55 new features. Primarily, the galvanometer has been designed to have a uniform response under all practical operating conditions. Charts and scales, which are 12 in. wide, conform to the latest calibration values for iron-constantan, chromel-alumel, and platinum-rhodium thermocouples. A humidity compensator is built into the instrument to correct automatically the pen position under all conditions of operation so as to offset

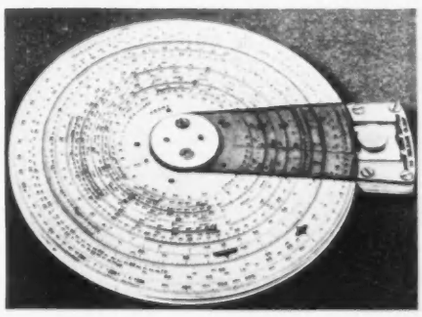


errors arising from expansion and contraction of the strip paper charts from moisture in the air.

Another feature of the potentiometer is the dustproof case that is equally suitable for wall mounting, front-of-board mounting, flush type panel mounting, or table mounting. The case is entirely inclosed and the galvanometer is likewise inclosed in an inside compartment with a glass window. The galvanometer pointer and suspensions are relieved of practically all stress by the introduction of a secondary pointer system, whereby a secondary pointer assumes a position in magnified proportion to the galvanometer pointer and then governs the adjustments of pen and slide-wire contact.

"Rotarule" Circular Slide Rule

Long scales are combined with great compactness in a circular slide rule, the "Rotarule," made by J. R. Dempster, 2204 Glen Ave., Berkeley, Calif. The rule is of white celluloid, 5 in. in diameter, and includes all the usual scales. The ordinary A and B scales are 50 in. long, coiled four times around the disks. A set of 13-in. scales is supplied for rapid multi-



plication and division. The circular construction eliminates the annoyance of "running off the end" experienced with straight rules. Other scales include a log-log scale, an inverted scale, trigonometric scales 17 in. long for all six functions, and other special scales.

"Lukenweld" Welded Rolled-Steel Gear Blanks

All-welded rolled-steel gear blanks for use in the manufacture of cut gears are available from Lukenweld, Inc., division of Lukens Steel Company, Coatesville, Pa. The welded steel gear blanks, which can be employed in the manufacture of spur, herringbone and helical gears, can be made in any size from 24 in. O.D. and up.

Although the all-welded gear blanks are ordinarily made from S.A.E. 1020 carbon steel, the rims can be fur-

nished in steels of special analyses, if desired. The hubs of the gear blanks are gas-cut from rolled steel shafting and the webs from rolled steel plate. The ribs are also cut from plate and formed into channels of the required section. The webs are arc welded to the hubs, and the reinforcing channels to the webs. The final operation consists of bending of the gear ring and arc-welding it in position to form the finished gear blank. Before shipment, the gear blanks are annealed.

Advantages of the gears are the homogeneity of the annealed rolled steel and freedom from blowholes, gas pockets, hard or spongy spots, and other defects. The gear rings, therefore, cut uniformly and the cut teeth are sound in structure.

PUBLICATIONS

FOR THE ENGINEER'S LIBRARY

ALLOY STEEL CASTINGS. The Duriron Co., Inc., Dayton, Ohio, has brought out an illustrated brochure on alloy steel castings of the "Durimet" and "Durco Nirosta" special analyses. Many representative types of castings are illustrated, and machining, welding, and heat-treatment data are offered, together with the physical and chemical properties of these two alloys.

BALL-BEARING LOAD COMPUTATION MANUAL. The Marlin-Rockwell Corporation, successors to the Gurney Ball Bearing Co., Jamestown, N. Y., has issued a booklet "Strom Ball Bearing Load Computation Manual" for engineers and designers. It simplifies the methods of calculating the load imposed on a bearing by various types of gears and drives. It is written very compactly and so as to make for ready reference.

BALL-BEARING PRODUCTS. S.K.F. Industries, Inc., 40 E. 34th St., New York, N. Y., has published Bulletin No. 204 illustrating its various products, such as ball, spherical roller and roller bearings, pillow blocks, hangers, and others.

CORROSION- AND HEAT-RESISTANT ALLOYS. The American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa., has reprinted "Tables of Chemical Compositions, Physical and Mechanical Properties, and Corrosion-Resistant Properties of Corrosion-Resistant and Heat-Resistant Allays," available in a special binder at $1.50.

FIBRE. The Continental Diamond Fibre Co., Newark, Del., is distributing a comprehensive catalog on vulcanized fibre, discussing the manufacture, machining, applications, and giving specifications and useful tables.

FIBRE. The National Electrical Manufacturers Association, 420 Lexington Ave., New York, N. Y., Vulcanized Fibre Section, has revised the standards for dimensions, tolerances and specifications for vulcanized fibre, sheets, tubes, rods and rolls. Copies of the new standard are available at $0.25 each.

GENERAL ELECTRIC PUBLICATIONS. The General Electric Co., Schenectady, N. Y., has published a series of bulletins as follows: GEA-214B, superseding 214A, on helicoil, sheath-wire immersion heaters; GEA-1262A, superseding 1262, on the type CR-9504 thrustors; GEA-1275, superseding 61511, on type BC, direct-current, fractional-horsepower motors; GEA-1352, superseding 81B, on type KG, squirrel-cage induction motors; GEA-1363, superseding 68946, on CR9042, form IG resistor units.

NICKEL CAST IRON. The International Nickel Co., Inc., 67 Wall St., New York, N. Y., has issued Bulletin No. 208 on "Ni-Resist," a Corrosion and Heat-Resistant, Nickel-Copper-Chromium Cast Iron, giving data on applications, welding, and the physical and chemical properties.

OIL CUPS. The Gits Bros. Manufacturing Co., 1846-62 So. Kilbourn Ave., Chicago, Ill., has issued catalog No. 31 on "Oil Cups, Automatic Multiple Oilers, and Oil Seals." This shows many new items and comprises 103 11x8½ in. pages, showing a wide diversity of equipment and listing the specifications and prices.

POSITIVE DRIVES. The Link-Belt Co., Indianapolis, Ind., has issued an illustrated book, No. 1293, describing its complete line of positive drives: Silent chain, roller chain, herringbone speed reducers, worm gear speed reducers, steel and malleable chains, and the P.I.V. variable-speed transmission. The booklet is entitled "A Saving at Every Turn" and is largely pictorial in treatment, showing typical installations of these various positive drives, together with brief descriptions of their scope.

PULLEYS AND SHEAVES. The Henry Lindahl Foundry & Machine Co., 5900 Ogden Ave., Cicero Station, Chicago, Ill., has announced Catalog No. 24, which covers the complete line of machine-molded pulleys, conveyor pulleys, and ball-bearing pulleys, together with sheaves of all types. Complete information and tables are given for the designing of V-belt drives. Prices are given.

PULLEYS. The American Pulley Co., 4200 Wissahickon Ave., Philadelphia, Pa., has issued a catalog of "American" Wedgbelt pulleys and drives. The booklet gives engineering information on V-belt drive design in concise form, and lists a wider selection than common of center distances in all standard ratios.

PUMPS. The Duriron Co., Inc., Dayton, Ohio, has published Bulletin No. 164 on Duriron centrifugal pumps in the Nos. 40 and No. 50 self-priming types.

RESEARCH SERVICE. The University of Michigan, Colleges of Engineering and Architecture, Department of Engineering Research, Ann Arbor, Mich., has issued a publication, "Research Service for Industry," illustrating the equipment available and discussing the types of fundamental research which can be undertaken.

SHEET METAL DATA. The U. S. Department of Commerce, Bureau of Standards, has published Circular No. 391 entitled 'Standard Thicknesses, Weights, and Tolerances of Sheet Metal (Customary Practice)". This publication is for sale by the Superintendent of Documents, Washington, for $0.10.

SKF DATA SHEETS. SKF Industries, Inc., 40 E. 34th St., New York, N. Y., has revised its load ratings for all bearings in bulletin No. 205-B, which supersedes all other engineering data sheets. The new ratings are based on established principles of fatigue life and also take into account improvements which have been effected in design, material, and manufacture. Dimensional data and speed and load ratings for all types of ball bearings, straight cylindrical roller bearings, and spherical roller bearings are included, as well as tables of shaft fits and housing tolerances. The bulletin contains 72 8½x11-in. pages.

SPEED REDUCERS AND GEARS. The D. O. James Manufacturing Co., 1114 W. Monroe St., Chicago, Ill., has published catalog No. 136 covering its line of continuous-tooth, herringbone reducers and gears, giving dimensions, prices and horsepower ratings, according to the speed and ratio. Illustrations of reducer installations are included.

STEEL. The Inland Steel Co., First National Bank Bldg., Chicago, Ill., has available a booklet, "Sizes We Roll and Standard Extras," including all standard extras and differentials applying to bars, plates, structurals, and rail steel products.

TESTING LABORATORY SERVICE. The Pittsburgh Testing Laboratory, Pittsburgh, Pa., has issued a brochure entitled "Fifty Years of Service to Industry," describing its service, which falls within four basic divisions—chemical, physical, inspection, and research, and showing some of the equipment employed and projects on which service has been rendered.

TIMKEN ENGINEERING JOURNAL. The Timken Engineering Co., Canton, Ohio, has published a revised edition of its loose-leaf catalog, the "Timken Engineering Journal", dated January, 1931. Dimension sheets for bearings with bores of 2½ in. and smaller have been changed to conform to the new tolerances of +0.0005 in., —0.0000 in. in bore, instead of +0.001 in., —0.000 in. General information on the application and fitting practices for these bearings is still included.

WHEELS. The Metzgar Co., Inc., Grand Rapids, Mich., has prepared a booklet on end-wood wheels of their manufacture, known as Catalog No. 31. It shows various types of standard and heavy-duty wood wheels for plant equipment, and lists the available sizes and specifications.

WORM-GEAR SPEED REDUCERS. The Foote Bros. Gear & Machine Co., Station "C," 215 No. Curtis St., Chicago, Ill., has issued catalog No. 301 on its "IXL HYGRADE Worm Gear Speed Reducers." The bulletin comprises 78 11x8½ in. pages, giving extensive information on the development and design of worm-gear speed reducers and listing the present sizes manufactured, their specifications, and prices.

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Chart for Determining Bending Moments

A CHART for obtaining the maximum bending moment for various types of beams with different loadings and span lengths is shown on the following page. On this page are given section moduli and moments of inertia for typical sections.

In the chart on the next page, the two left-hand scales give total load in pounds, and also various conditions of loading as listed diagrammatically under *C*. In all cases, the total load, be it uniform or distributed, must be used. The charts under *C* designate concentrated loads as *P*. These loads are to be used in the *W* scale, as noted on the chart. The center line, marked "Turning Scale," is where the index lines cross, as shown in the example. The scales on the right, labeled *L* and *M*, are the length *L* in inches between supports or support and load, and the maximum bending moment *M* expressed in pound-inch units.

When using the chart, two known variables, such as *C* to *L* or *W* to *M*, should be connected in the manner shown by the chart key. The turning scale will be cut. At this intersection the point of a sharp instrument is placed and the straight edge swung until the other known variable is reached. Then the opposite end of the straight edge will cut the scale of the unknown variable, giving the answer. A large variety of problems can be solved merely by moving the straight edge.

Example 1—A cantilever beam is 4 ft. long and has a load of 800 lb. concentrated at its free end. This might also be a shaft with an overhanging fly-wheel. Neglecting the weight of the beam, find the maximum bending moment in lb.-in.

Place a straight edge on scale *C* at 1, and set the other end at 48 in. on scale *L*. Place a pointed instrument on the turning scale, guided by the straight edge. Swing it around the point until 800 lb. is reached on scale *W*. The answer will be seen on scale *M* to be 38,000 lb.-in. The correct answer as computed is 38,400 lb.-in.

Example 2—Should the weight of the beam or shaft of Example 1 be given as 3.03 lb. per in., the problem would be solved as follows. Lay the straight edge on line *C* at 2 and cut line *L* at 48 in. Swing straight edge around marked point, on turning scale, to 146 lb. (3.03 lb. per in. × 48 in.) on scale *W*. Then scale *M* will show the answer to be 3,500 lb.-in. The computed figure is 3,504. Considering this bending moment to have a positive sign, this figure should be added to the bending moment previously found for the concentrated load, which is also positive. The total maximum bending moment will be 38,000 lb.-in. plus 3,500 lb.-in., or 41,500 lb.-in. Computations would show the exact figure to be 41,904.

Two or more loading combinations may be solved. It must be remembered when dealing with problems involving more than one loading that the bending moments must be added algebraically. Those with like signs should be added; those with opposite should be subtracted.

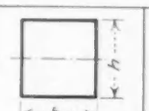
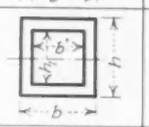
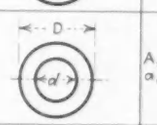
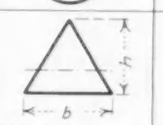
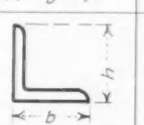
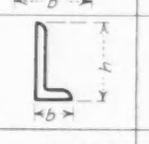
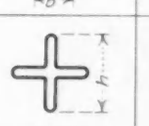
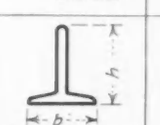
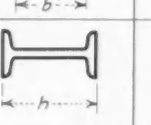
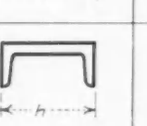
Shape of Section A=Area		Moment of Inertia	Section Modulus
	Solid Rectangle	$\frac{bh^3}{12}$	$\frac{bh^2}{6}$
	Hollow Rectangle	$\frac{bh^3-b_1h_1^3}{12}$	$\frac{bh^3-b_1h_1^3}{6h}$
	Solid Circle	$\frac{1}{64}\pi D^4 = 0.0491 D^4$	$\frac{1}{32}\pi D^3 = 0.0982 D^3$
	Hollow Circle A, Area of large section; a, Area of small section	$\frac{AD^2-ad^2}{16}$	$\frac{AD^2-ad^2}{8D}$
	Solid triangle	$\frac{bh^3}{36}$	$\frac{bh^2}{24}$
	Even angle	$\frac{Ah^2}{10.2}$	$\frac{Ah}{7.2}$
	Uneven angle	$\frac{Ah^2}{9.5}$	$\frac{Ah}{6.5}$
	Even cross	$\frac{Ah^2}{19}$	$\frac{Ah}{9.5}$
	Even tee	$\frac{Ah^2}{11.1}$	$\frac{Ah}{8}$
	I-beam	$\frac{Ah^2}{6.66}$	$\frac{Ah}{3.2}$
	Channel	$\frac{Ah^2}{7.34}$	$\frac{Ah}{3.67}$

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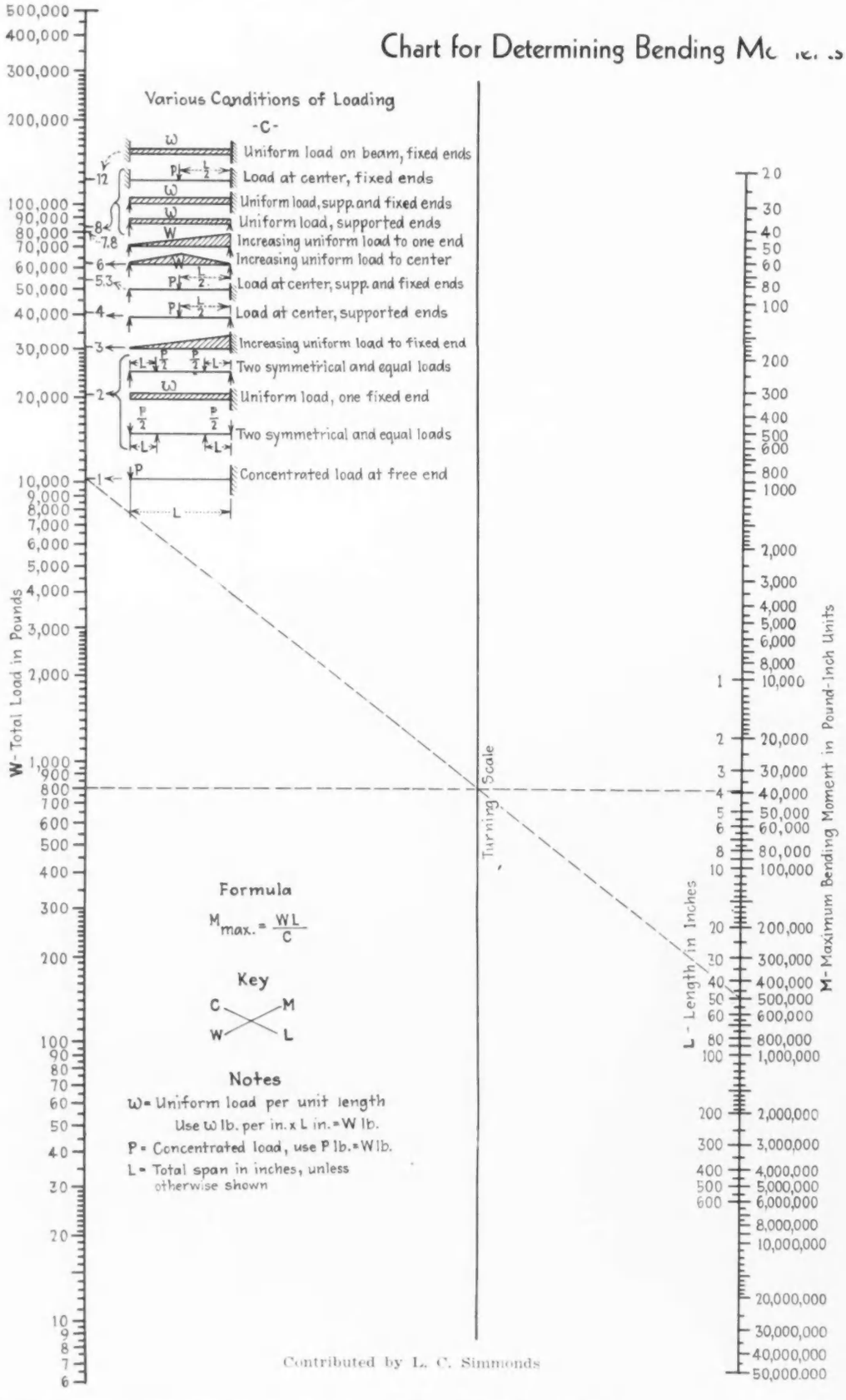
Chart for Determining Bending Moments


Various Conditions of Loading
-C-
Uniform load on beam, fixed ends
Load at center, fixed ends
Uniform load, supp. and fixed ends
Uniform load, supported ends
Increasing uniform load to one end
Increasing uniform load to center
Load at center, supp. and fixed ends
Load at center, supported ends
Increasing uniform load to fixed end
Two symmetrical and equal loads
Uniform load, one fixed end
Two symmetrical and equal loads
Concentrated load at free end
W- Total Load in Pounds
L - Length in Inches
M- Maximum Bending Moment in Pound-inch Units
Turning Scale
Formula
$M_{max.} = \frac{WL}{C}$
Key
C M
W L
Notes
W= Uniform load per unit length
Use w lb. per in. x L in. = W lb.
P = Concentrated load, use P lb. = W lb.
L = Total span in inches, unless otherwise shown

Contributed by L. C. Simmonds

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